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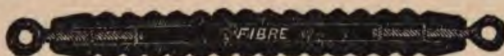

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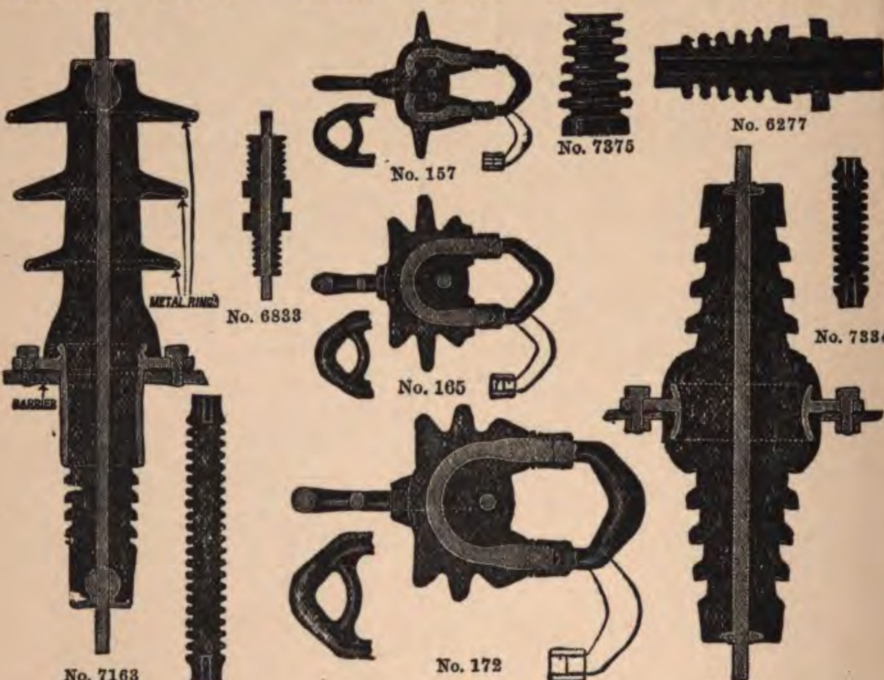

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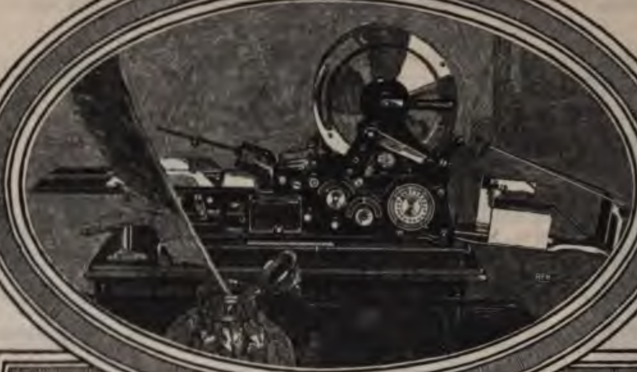

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Vol. 45, No. 9 SEPTEMBER, 1919 Whole No. 199

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THE UNITED STATES NAVAL WAR COLLEGE[1]

By Rear Admiral William S. Sims, U. S. Navy

Let us at the reopening of the college course begin by making sure that we have a clear understanding of why we are here, and particularly a clear understanding of the nature of the Naval War College and its functions.

It is not a college at all in the ordinary sense of the term. It belongs to no religious denomination. It has no fixed policy. Neither its head nor its staff is permanent. They are fleet officers and are continually being replaced by other officers from the fleet. The college is, in effect, part of the fleet, and it exists solely for the fleet.

The students bring to the college their practical fleet knowledge and experience. They are asked to consider this practical knowledge and experience in connection with the principles of warfare. These principles of warfare are nothing but deductions from the accumulated experience of those who have gone before us, including of course the acknowledged masters of war.

The results of this combination of the experience of the present with that of the past will constitute the principles and methods in current use at the college, and which you fleet officers will help further to develop and to apply.

[1] Address delivered at the opening course for class of June, 1919.

When you finish your course you will carry these principles back to the fleet, and will, I trust, be guided by them.

Some of you will doubtless be assigned to the staff and will pass these principles on to newcomers, who, in their turn, will contribute their fresh fleet experience. And in this way the process of development will be carried on in actual continuous cooperation with the fleet and with the service.

You will thus recognize that this is not really a college. Perhaps it would have been better if it had never been so designated, for in reality this assemblage is nothing but a board of practical fleet officers brought together here to discuss and decide the extremely important question of how we would best conduct naval war under the various conditions that may arise.

You should think of this board as belonging to the fleet—as being what you might call a fleet board on strategy and tactics, frequently making reports to the fleet and the service upon these vital subjects.

You should never lose sight of the fact that we are all practical fleet officers; that we shall go back to the fleet and be replaced by others from the fleet; that our work is wholly practical, because we base our conclusions upon our own experience and upon that of those who have gone before us; and that therefore there can be nothing theoretical about the principles of fighting that we decide to be the correct ones, or about the methods we devise for carrying them into effect.

Some officers complain that they do not understand the terms, the strange words, used by the college. I do not understand any of the strange words used by golfers, because I have never played the game, but I understand that some such words are necessary. They are equally necessary for the game of war. Every art must necessarily have its own rules, principles and methods, and these must have names if we are to talk about them—and we cannot practice an art or play a game without talking about it.

The principles of the war game constitute the backbone of our profession. All other kinds of nautical knowledge and experience, for example, that required for handling ships, maneuvering fleets, etc., will avail us nothing when it comes to war if we have not learned the game, that is, if we do not know how to handle naval

forces, both strategically and tactically, at least as well as our opponents.

This game, like all other games, can be learned only by playing it. The mere study of the art of war, even though very thorough, will no more make you competent in the practice of strategy and tactics than book knowledge of golf and tennis will make you good players. It is for this reason that the college insists not only upon the study of the art of war, but also upon the practice of it in chart maneuvers and upon the tactical game board.

You will find that by playing these practical games you will gradually acquire confidence in your ability to estimate a situation correctly, reach a logical decision, and write orders that will insure the mission being carried out successfully.

When you can do this you will have accomplished that which it is the principal function of the college to teach. And having accomplished this, I hope you will not consider that you have thereby ceased to be practical officers. Also that you will not knowingly allow others to consider you "highbrows."

There has been wasted during this war a great deal of effort, much valuable material, and even many valuable lives because of the lack of training necessary to reach logical decisions based upon the well-known immutable principles of war. This is not the time or place to inform you of these incidents. But let it suffice for me to assure you that the constant prayer of those who bear great responsibility in time of war is that they may be spared the results of the decisions of the so-called practical officers who are ignorant of the art of war and who have not been trained to think straight—that is, who have not been trained to make a a logical estimate of a situation.

Though we are now beginning a new course, it should not be assumed that there is at present anything original about it. We are beginning where our predecessors left off. It would be presumptuous for us arbitrarily to make changes in the course in the absence of experience upon which to base such changes.

The essential results so far attained were due to a long process of development. Improvements were continuously made until the results demonstrated that the course and the manner of conducting it were accomplishing the college's true mission of turning out officers reasonably well instructed in the art of war and trained in its application.

This development was not due solely, or perhaps even chiefly, to the staff, but was greatly aided by the criticisms of the members of the various classes, based upon their various experiences.

Remembering that we are practically a fleet board for improving our efficiency in making war, it follows that criticisms of college methods are more than welcome, provided they are based upon the experience of those who have taken the course. It is recognized as natural that officers coming to the college for the first time will not always understand the reasons upon which the methods of instruction are based, and will therefore be inclined to criticise them. But as sound conclusions can be safely based only upon adequate knowledge and experience, it would manifestly be unprofitable to consider the criticisms of officers who are just beginning the course. It is for this reason that the college does not invite suggestions as to changes in essential features until after the students have finished the course.

Note that the above refers only to suggestions as to essential features of the course, and not to minor suggestions which may occur to you from time to time. We recognize that these may be very helpful, and we shall be glad to receive them. For example, suggestions concerning mechanical features of the tactical and strategic maneuvers are more likely to occur to the newcomers than to those who become familiar with these methods through constant use.

At one time we invited the criticisms of the beginners and also of the graduates. First as a student and then as a graduate I took an active part in these criticisms, and my experience showed my criticisms as a beginner to be unsound.

Perhaps an account of this experience would be more or less convincing. It is contained in a letter which I wrote to Admiral Knight when he was about to assume the Presidency of the War College in 1913. The letter is as follows:

TORPEDO FLOTILLA, ATLANTIC FLEET,
U. S. S. "DIXIE,"
Newport, Rhode Island,
11 October, 1913.

My dear Admiral:

A few days ago I had a significant experience at the War College; and when I learned that you were to be ordered as President, it occurred to me that I might send you an account of this experience on the bare chance that it would be of some use to you.

The occasion was the usual conference held on the last day of the summer course for the purpose of discussing the advisability of making changes in methods of instruction.

As usual upon these occasions, certain of these methods were opposed by some of the student officers, and were supported by the staff and by a number of former staff officers and officers who had completed the long course and who had been invited to attend.

The principal point at issue was as to the advisability of continuing that feature of the present applicatory system of instruction during the long course which requires the student officer to show, by written theses on the various subjects and by written solutions of the various problems, that they are continually making good, that is, that they really understand each subject.

Generally speaking, the result of the discussion showed the following significant conditions:

1. Practically all of the candidates for the long course held that all the writing required was largely a waste of time; that if this were eliminated there would be more time for reading, for study, for instruction, for war games, etc.

2. Without exception, all those officers who had taken the long course, or who had served on the staff, strongly supported the present methods of applying the applicatory system.

3. With, I believe, no exceptions, all these latter officers had, at the beginning of their long course, opposed the methods they now unanimously approve.

I am one of those who were originally in opposition. At the conference in question I therefore had the peculiar experience of listening to the new men putting up the very same arguments which I had used against the system two years ago, and which I, and all those who took the long course, now recognize to be wholly in error.

From this experience it would seem evident that, as might be expected, only those who have taken the long course as now conducted are competent to express an opinion of value as to the benefits to be derived therefrom.

Of course there must be the adequate amount of reading, study and instruction now provided by the course; but it is my opinion that any course of instruction which is not based upon the applicatory system as now applied—that is, which does not require the student to show that he is making good—is of relatively small utility in *training* officers in the *practical* application of the principles of warfare.

I tried to make this point clear in a lecture which I delivered at the Naval Academy and which was subsequently printed and circulated in the service.

Congratulating you upon your detail to this important duty, believe me,

Very sincerely yours,

WM. S. SIMS.

Rear Admiral A. M. Knight, U. S. N.,
Commanding Atlantic Reserve Fleet,
U. S. S. *Wisconsin*, Navy Yard, Philadelphia, Pa.

In order that the criticisms of the graduating class may be as comprehensive and valuable as possible, the students should keep in mind that one of the last papers that they will be called upon to write will be one giving their views upon the course as they found it, and making suggestions as to improvements.

Before beginning the course it is necessary to understand, without possibility of mistake, what the college proposes to accomplish and what its limitations are. It should first be clearly understood that the college does not propose to establish a code by which naval warfare can be conducted. It does not propose rules for meeting various situations. This would be wholly impossible because of the infinite variety in the character of the conditions and situations. Each problem must be dealt with on its merits, in accordance with certain general principles which it is the object of the college to develop and to teach.

That is, the college aims to supply principles, not rules, and, by training, develop the habit of applying these principles logically, correctly, and rapidly to each situation that may arise.

This habit can be acquired only through considerable practice, hence the numerous problems in strategy and tactics.

The process shows the necessity of:

1. A clear conception of the *mission* to be attained.

2. An accurate and logical *estimate of the situation*, which involves a systematic mustering of all information available and a discussion of its bearing upon the situation under consideration.

3. A *decision* that is the logical result of the *mission* and the *estimate*.

This process constitutes a course of training in handling war situations. The problems are especially designed to show the correct application of the principles of strategy and tactics.

Each officer is required to present a solution of each problem. Any particular solution is, of course, one of many possible solutions, but it is acceptable if it results in a logical decision. In a number of solutions we may recognize one as manifestly the best of those under consideration.

Each problem is solved by a member of the staff in consultation with other members. This staff solution may or may not be better than any solution submitted by the class. As it is based upon principles believed at the time to be correct, and as it is the

work of officers supposed to be indoctrinated in these principles, it may be assumed to be sound.

That is all that is claimed for it. The college does not claim to show what should be done in particular cases, but hopes that the college training in the application of the principles of warfare, to problems based upon modern conditions, will enable you to reach acceptable solutions in any case that may rise.

As there sometimes arises the impression that the college is, or should be, the plan-making branch of the navy, it may be well to repeat the explanation of its proper function that has been given by former Presidents.

It is true that the college could supply plans as required if it was provided with a special staff for this purpose many times larger than its present staff, but as the data essential for this work is necessarily continuously accumulating in the various branches of the Navy Department, it is manifest that such a planning section should not be located here.

It would be wholly impossible for the teaching staff to undertake plan-making in addition to its own work. It is for this reason that the college does not assume, and cannot undertake, any administrative functions. Administration involves action, and the essential function of the college is not action, but training for action.

While we cannot supply strategic plans required by the Navy Department we hope to supply officers who can formulate such plans.

Similarly, we cannot supply tactical battle plans to fit all conditions that may arise in the fleet; but if the college course proves successful it will supply commanders-in-chief and fleet staff officers competent to prepare and carry out such plans. If the college should be required to do planning work it would cease to be a teaching institution and become a part of the General Staff, with the duty of supplying plans instead of officers trained to prepare plans.

Recalling a statement made above, namely, that "The college does not claim to show what should be done in particular cases," it follows that it should never be called upon in any particular case to pass judgment upon solutions reached or decisions made by any other branch of the navy.

This is specially important in the case of decisions made in carrying out tactical and strategic maneuvers, for, manifestly, if the college cannot even assume that its own staff's solutions are superior to those of the members of its classes, it cannot properly be asked to assume the ability to pass judgment upon the decisions of those who conduct the maneuvers.

Moreover, to place the college in such a position would result in a conflict of opinions with the inevitable result that antagonism would be created between the college and the service—and if the college is to succeed in teaching the art of war to willing pupils, it must at all times work in complete harmony with the service.

There is one other subject which has received too little attention heretofore, and that is the extremely important quality called "military character."

Some officers have admirable knowledge and experience but fail in this quality of character. They are honest, loyal, zealous, and devoted. They know the principles of warfare but do not always exercise the will and self-control to apply them. They understand the principle that in extensive organizations work should be divided according to specialties and the head of each section given full responsibility and authority, but they do not apply it—hesitating to allow authority, even in minor matters, to pass out of their hands. This subject will be taken up in due course. Its importance is due to the fact, often demonstrated, and particularly so in the great war, that not infrequently officers of quite exceptional ability, knowledge, experience, and energy failed to succeed because they did not understand, or did not apply, the principles of military character.

The service is to be congratulated that the Navy Department has decided to increase the capacity of the college. The Secretary of the Navy has just signed an order which indicates the desirability of every effort being made to provide a staff of thirteen officers, and a class of thirty student officers in June and January, thus adding sixty trained officers to the navy each year.

Though it may be possible in the future to increase this number somewhat, still it can never be sufficiently increased to include the entire commissioned personnel. But as it is necessary that the essential principles and methods taught by the college be understood by the service, it is apparent that opportunity to acquire this knowledge should be provided.

To this end the college offers to all officers the advantages of a correspondence course, the extent of which is limited not by what the college can provide but by the average time which can be devoted to this work by officers occupied in the various duties ashore and afloat.

While we may reasonably hope for very appreciable results from this course, still there can be no doubt that we must depend largely upon graduates to illustrate by their example the principles and practices they have learned at the college.

Judging from my own experience, you will find your studies at the college of absorbing professional interest; and you may be sure that it shall be my object and that of the staff not only to facilitate your work in every practicable way, but also to render your stay here as agreeable as possible.

In the confident hope that we may succeed in both of these objects, I take great pleasure in welcoming you to the college.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

Prize Essay, 1917[1]

COMMERCE DESTROYING IN WAR

By Captain Lyman A. Cotten, U. S. Navy

Motto: Easy methods; inconsiderable results

The science of war as we know it to-day, like all other sciences, is the result of progressive development. As war implements changed by successive stages from the clubs and stones of savagery to the high-power guns of to-day, the method of using these implements necessarily changed also, but the object of war has constantly remained the same, namely the reduction of one's opponent to such a state of impotence, actual or prospective, that he considers it the part of wisdom to submit to the will of his enemy.

Since war ceased to be a general *mêlée* in which one savage tribe fell upon another and fought by brute force until one was exterminated or enslaved, man has been more and more seeking to employ his brains as an aid in fighting. Many have reaped the advantage of more effective weapons or a more effective use of their weapons, but many more have striven in vain for a short cut to success in war—some patent nostrum by which victory could be won without taking and giving the hard blows that make war so disagreeable.

In the early ages of human development, sea-borne commerce was practically non-existent, but, so soon as civilization reached the era of colonization, it quickly became an important part of the economic life of the countries that faced the sea, and consequently of great importance in war.

[1] Essay received by U. S. Naval Institute, December 30, 1916. This essay was awarded the prize in 1917, and was through error published in a deleted form. It is now published in its entirety because a large and important portion of the essay was omitted in the June issue.

A merchant vessel on the high-seas is particularly helpless to resist force, and furthermore constitutes, with her cargo, a concentrated form of wealth. The sea offers no facilities for concealment, and the lanes of maritime commerce converge in certain localities on account of physical features, as islands, straits or smaller seas, making the location of merchant ships fairly simple. Seeing this, some seeker for success-in-war-without-fighting evolved the idea of commerce destroying as the long-sought short cut to easy, economical and successful war.

He argued in this way. We will build ships of less cost than heavy men-of-war, and send them out to prey upon this helpless maritime wealth of our enemy. These ships will infest the regions in which his merchant ships converge, and by capturing or destroying them we will bring him to the verge of bankruptcy, at the same time enriching ourselves at his expense. This reasoning seemed plausible, and this means of winning war on the sea appeared to be both simple and economical, and straightway there arose a school of adherents, both naval and civilian, though it must be said that it always appealed with more force to those who *direct* the conduct of war than to those who have to execute it. In any case, from that day to this, most maritime wars have seen commerce destroying used with varying degrees of insistence.

That great student of naval history Admiral Mahan said, "There are certain teachings in the school of history which remain constant," and it would seem to be not without interest to see what lessons the school of history contains on commerce destroying in war, with special attention to its final result and its association with victory or defeat. Such lessons should be of particular interest at this time when commerce destroying is being undertaken on an extensive scale and a new instrument, the submarine, is being employed in its service.

A survey of the history of commerce destroying will necessarily have to be very brief to be compassed in reasonable space, but even so, we may be able to deduce something therefrom of value to our country and of interest to ourselves. Such a survey may be divided logically into two parts, *i. e.*, commerce destroying in former wars and commerce destroying in the present war. By handling the subject in this way we may more accurately gauge the present by the known results of the past, and after all such a

a survey can only have real value in just so far as it leads to a clearer understanding in the momentous present.

It is not necessary for our purpose that we go back in history for a further period than to enable us to cite sufficient examples upon which to base our deductions with reasonable safety. By the middle of the sixteenth century maritime commerce had risen to a position of great economic importance in the national lives of several European countries, particularly Spain. Her galleons usually voyaged several together, the better to defend themselves from the pirates and freebooters of that day, and on their homeward voyages were laden with cargoes of great value.

When England under Elizabeth and Spain under Philip went to war, partly for "the glory of God," and partly for the privilege of trade with America, the Spanish Navy was at the height of its glory, while the English Navy had yet to win its distinction, and to become imbued with those correct principles of naval warfare that for so long have maintained England in her world position. At this time England was a comparatively poor country, and first-line men-of-war were expensive, so for some years she made direct war on the commerce of Spain her chief objective, at the same time pillaging and destroying her colonial cities as occasion permitted.

At first this mode of warfare seemed to meet with considerable success, but, none-the-less, when Philip began building and fitting out a vast number of fighting ships, England found herself threatened with invasion, *which commerce destroying was powerless to stop.* Though Drake covered himself with glory when he "singed the King of Spain's beard for him" at Cadiz, the preparations for invasion were only delayed, not stopped.

After much delay through vacillation and economy, the English began to prepare a fighting fleet, and finally were able, though vastly outnumbered, to "defy the Duke Medina" and scatter to the winds the Great Armada.

Then it was that the English found that in saving England from invasion *by destroying the Spanish war-fleet,* they had also greatly simplified the problem of trade with America, and had put the commerce of Spain almost at their mercy.

For fifty years or more after this, England put her reliance in maritime war in her fighting fleet, but plausible fallacies die hard, and in the second Anglo-Dutch war the English showed they had

only half-learned their lesson. Charles II, as usual, was short of money and, besides, the war was waged primarily over the question of maritime commerce, so again England made direct war on commerce, though several fleet actions took place. In these actions the English Navy, while winning no decisive victories, still maintained its position very satisfactorily. After the battle off the North Foreland, Charles, for purposes of economy, decided to put most of his fighting ships out of commision, and concentrate upon commerce destroying. The ineffectiveness of such action may be clearly seen, since the Dutch fleet entered the Thames River in 1667 and inflicted enormous damage, and England was quite willing to come to terms of peace containing no advantages for herself, except escape from the then vastly superior Dutch fleet.

England wholly learned her lesson this time, and not since the Peace of Breda, signed after De Ruyter's raid up the Thames, has she used commerce destroying as a primary mode of maritime war. On the contrary her own commerce has been attacked directly a number of times, but nevertheless it has continued to grow until it has become greater than that of any other country.

France has been the most faithful adherent of commerce destroying, having used it intermittently in her naval wars for over a hundred years. Over and over again it was demonstrated that it led to no considerable military advantage, but still she clung to it with a tenacity worthy of a better cause.

In the third and last Anglo-Dutch war, in which France was allied with England, each of the powers used their fighting fleets, rather than commerce destroying, and finally the Dutch sea power was destroyed and with this destruction Dutch commerce was *automatically* toppled from its pedestal of supremacy.

Again in the War of the League of Augsburg we see France taking the sea with fighting fleets and England, now allied with the Dutch, was partially defeated at the Battle of Beachy Head, though the next year Admiral Russell took the sea with a greater force than Tourville could gather. However, by skillfully handling his fleet Tourville drew the English fleet well out into the Atlantic, and during its absence the French light cruisers fell upon English commerce and inflicted enormous damage.

During this campaign, it should be noted, there was no actual fighting, and yet the injury to England was considerable. Here

we probably have the origin of the French belief in the efficacy of commerce destroying as a primary mode of warfare on the sea. "Why," they argued, "have expensive fighting fleets when such injury can be done our enemy by cheaper cruisers and privateers." They quite overlooked the fact that their main fleet, by drawing off the English fleet in pursuit, gave to their cruisers the temporary immunity that enabled them to operate successfully.

The following year the French fleet was badly worsted at La Hogue, but direct war on commerce was continued on a scale previously unknown. Gradually, though, as the French Navy declined in fighting ships, their commerce destroyers were chased from the seas, and with sea control in England's hands French maritime commerce disappeared and its place was taken by England's increasing fleet of merchant vessels. As the disparity in fighting ships increased it became progressively more dangerous for the French commerce destroyers to go to sea, and more difficult for them to make captures even when they could keep the sea.

The part of a commerce destroyer is to destroy merchant vessels, not to fight, and consequently French commerce destroyers were usually so busy keeping out of the way of English men-of-war that they had but little opportunity to ply their vocation. Where the lanes of commerce converged, and captures should have been easy, England stationed men-of-war more powerful than commerce destroyers and the French ships had to seek their victims in more sparsely traversed regions where captures were few. The peace terms were most humiliating to Louis XIV, and his comparatively successful war on commerce was in no way comparable to the *military* success on the sea of his enemy.

When the war of the Spanish Succession began France at first tried squadron warfare in rather a half-hearted way, but the ease and seeming economy of war on commerce again lured her away from the true principles of naval warfare. During the first five years of the war France captured or destroyed, on an average, about 230 English ships per year, but England captured more French ships during that time, though her fleet was primarily engaged in military operations that were not without great influence in leading up to the treaty of Utrecht, so disastrous to France. The individual exploits of some of the French privateering commanders were illustrious, but none-the-less the end of the

war found France humbled and defeated and English sea power with its protecting wing at its height.

In the war of the Austrian Succession the naval history of the war of the Spanish Succession in effect repeated itself. France started off as though to fight her part in the war on the sea, but soon commerce destroying was again the accepted mode and the treaty of Aix-la-Chapelle in 1748 restored to France none of the concessions made by the treaty of Utrecht.

In the Seven Years' War, between France and England we see another deplorable result of seeking an easy mode of warfare, for though the French fought on occasion, they were ever on the defensive—always willing to await the attack of their enemy—rather than seeking in aggressive action to deliver the heavy blows necessary to overcome an enemy, even if heavy blows have to be accepted in doing so. They seemed to have thought that by making a *pretence* of fleet warfare they could impart the element needed to make commerce destroying effective as a means of bringing their enemy to terms.

It is quite true that England suffered the loss of many merchant vessels, but French commerce was practically denied the use of the sea by the English fleets, and, after all, the percentage of loss to the English was small. Her ships were now carrying both her own normal commerce and that abandoned by France. The financial loss to England was scarcely more than a small war tax upon maritime commerce, never amounting to more than three or four per cent per year. In the meantime England was taking the French colonies one by one, far more than compensating herself in a financial way for the small war tax, and at the same time establishing the foundation of the British Empire.

The treaty of Paris in 1763 left in English hands Canada, Nova Scotia, the Ohio valley, the country east of the Mississippi to New Orleans and numerous small West Indian islands, and *a navy powerful enough to keep them.* The practical results of France's war on English commerce were absolutely without effect when it came to signing the treaty of peace. Comment is unnecessary.

In the maritime part of the War of the American Revolution, France swung away from war on commerce and rather consistently followed squadron warfare, but the infection of non-aggressive action was still there as a legacy from the less rigorous mode

of warfare. Still the results of the war were much more satisfactory to France than were those in which war on commerce had been accorded a more prominent part.

It is nothing short of remarkable that the French, after their years of failure to attain any material advantage through war on commerce, should again revert to it, yet they did no less. In the French Revolution the Committee of Public Safety announced "The new system of political warfare that your committee has adopted. . . . . All our plans, all our cruises, all our movements in port and at sea, will have for object only to ravage its (England's) commerce, to destroy, to overturn its colonies, to force it finally into a shameful bankruptcy." That this system was termed new, can only be attributed to an utter lack of familiarity with naval history in general and with French naval history in particular.

It cannot be denied that for some years many English merchant ships were captured and it was doubtless a source of annoyance to English merchants, but the monetary value of these ships was but a very small part of the total expense of war, and during these years, despite captures, English commerce actually increased. The "shameful bankruptcy" failed to materialize. As a matter of fact the French captures per year averaged only from 2.5 to 3.0 per cent of England's merchant fleet, which does not seem a very heavy war tax.

In the Napoleonic Wars, the French, though their military operations were directed by a master mind, still hoped to gain some advantage through war on commerce at sea. They fought several memorable fleet actions, it is true, but they were always the attacked, and it would seem as though the hearts of their seamen were ever longing for some less violent form of warfare, some easy mode of success, some method of "making war without running risks," as Napoleon himself said. For several years after Trafalgar, war on commerce was followed with energy and persistence, but one by one the French cruisers were sunk, captured or wrecked, and their own shipping, lacking the protecting influence of fighting squadrons, practically disappeared from the high seas.

The numerous examples from French history have been cited, because for a hundred years there were practically only two naval powers, and their modes of conducting warfare were

diametrically opposite. England, profiting by the lessons learned from her wars with Spain and Holland, took the sea, whether inferior or superior in numbers, ready and eager to fight, and her objective was ever the fleet of her enemy. France over and over again sought by inconclusive maneuvers and commerce destroying to bring her enemy to terms. The known results of the various wars individually, and the cumulative total of a hundred years, illustrate more clearly than mere words may hope to do, the strength of the one method and the weakness of the other. It may be accepted as a maxim of warfare that what is worth having is worth fighting for, and easy methods lead to inconsiderable results.

Only a few more examples of commerce destroying prior to the present war will be mentioned, and these only because being less remote historically, they are more generally familiar, and because one famous example of war on commerce is of particular interest to Americans.

During our Civil War the South, having but few men-of-war, used them largely in warring upon the sea-borne commerce of the North. Three ships, the *Florida,* the *Shenandoah* and the *Alabama,* were particularly successful; but the importance of their operations has been vastly magnified by the romantic appeal of their careers, and the concurrent decline in American shipping that has lasted to the present time.

The *Alabama* was the most celebrated of these commerce destroyers, and yet she averaged only three captures per month, and the total loss by capture of the commerce of the North during the entire war, according to a Congressional investigation made soon thereafter, was only five per cent of the whole, or one and one quarter per cent per year. This does not impress one as being an exorbitant war tax on any branch of commerce. That these commerce destroyers were able to accomplish even as much as they did was due more to faulty methods of commerce protection on the part of the North, than to any inherent value in this mode of warfare.

While the commerce of the North was very seriously injured by the direct attack upon it, it is generally lost sight of that the commerce of the South was practically prohibited on the high-seas by the purely military disposition of the Northern fleet. That this military disposition was a most effective factor in defeating the

South, no one familiar with the history of the Civil War can doubt. At the same time it is highly improbable that the total result of the Southern commerce destroyers prolonged the losing struggle of the Confederacy by so much as one day, nor would the result of the war have been different had there been a hundred *Alabamas*—so long as they were used purely as commerce destroyers.

The permanent decline of American maritime commerce was due much less to commerce destroying than to legislative, economic and fiscal causes subsequent to the war.

In the Spanish-American War neither combatant had a merchant fleet worthy of the name, and so it affords no examples of war on commerce, though our men-of-war, of course, captured such Spanish merchant ships as came their way. The war was in effect concluded by the destruction of the Spanish fighting squadrons at Manila and Santiago.

In the Russo-Japanese War the Russian division based on Vladivostok made several raids on Japanese commerce, in one case getting as far down as the entrance to Tokyo Bay, but the influence of these raids on the final result of the war was absolutely nil. The Japanese refused to draw any part of their main fleet away from their strictly military objective—the Russian fleet of fighting ships in Port Arthur.

Even in this mere outline sketch of commerce destroying in past wars, it may be seen that certain facts repeat themselves with such consistency that we can but conclude that they belong to the constant teachings in the school of history. We see that commerce destroying has ever been used by the nation having the weaker navy—weaker in fighting ships, in morale, or in the willingness to run the legitimate risks of normal war on the sea; that the main incentives to such warfare are economy and the longing for an easy way to success in war; that the surest way of accomplishing the ruin of an adversary's commerce is to destroy the fighting force that protects it, rather than to make direct war on commerce; that commerce attacked directly sometimes actually increases in war, when protected by adequate fighting ships properly used; that at its best commerce destroying has been able to inflict no more than a small percentage of loss on an enemy's total maritime commerce; that the monetary loss to an enemy caused by attacking her merchant ships has never amounted to more than a very small

fraction of the cost of war; that an enemy country has never been brought to the verge of bankruptcy through attacking its commerce; that war on commerce has never produced concrete results of moment tending to reduce an adversary to a state of impotence; and finally that commerce destroying has consistently been practiced by the nation that was, sooner or later, defeated in the essentials of the wars in which this form of warfare was employed.

It is hardly within the bounds of reason that the foregoing clearly discernible facts should have been merely coincidental. There must be some reason for the results, and when these results are similar again and again this reason must be fairly constant, if not fundamental. The results in war are after all the essential things, and when a mode of warfare fails to produce results the reasons for its adoption cease to be of particular interest.

So it is beside the question to advocate commerce destroying in war on account of its original economy, for on the whole its operation is very uneconomical, looking at the war as an entity rather than as a number of parts; it is of no moment to state that war on commerce will reduce an enemy to bankruptcy, since it has never done so; it is futile to the extreme to employ such warfare hoping to win victory thereby, since the history of a hundred and fifty years and more show it to have been ever associated with defeat.

It is not intended that the conclusion is to be drawn that the final results of the various wars were absolutely determined by the types of naval warfare employed, but beyond question the successful use of sea power did have a great influence in each case, and direct war on commerce does not seem to be the most advantageous use of sea power. Since the war is conducted by force it must be terminated by the destruction of force, and so far no easy method of accomplishing this has been evolved.

War on commerce has its uses, for it annoys and weakens an enemy, but as a primary, peace-compelling undertaking it does not produce military advantages of importance. The best way for a combatant nation to protect its own commerce and at the same time drive the commerce of its enemy from the sea, is to destroy the fighting ships of that enemy. That much is certainly true if we are to accept the lessons of history up to the present time, and we are safe in assuming that it will remain true until basic conditions have changed or some new method or instrument in com-

merce destroying is utilized that fundamentally changes the problem.

From the foregoing we are forced to draw certain conclusions as to the efficacy of commerce destroying in past years, judgment being based solely upon the cold and impartial historical record. As historical repetition is accepted as a truism one might have expected to see in a modern war an effort made by one or more belligerents to utilize direct war on commerce as a means to a military end. Therefore it should occasion no surprise to find one of the belligerents in the Great War undertaking direct war on commerce on an extensive scale. There can hardly be any doubt but that the history of such warfare is thoroughly familiar to that belligerent; but at the same time it is only reasonable to suppose that she thinks there is some new or peculiar condition that may give to such warfare the power of inflicting such damage to the military situation or wealth of her enemies, that it will have the effect of forcing a peace under terms favorable to herself, or this form of warfare has been adopted because of the belief that other and more dangerous forms would be doomed to defeat, the effect of which would react to greater disadvantage than the failure of war on commerce to produce important military results.

It would seem promising of interest to review briefly commerce destroying in the present war to date, from the view-point of a neutral outsider, with the objects of ascertaining the points of similarity or difference between what the history of commerce destroying in former times indicates might have been expected, and what has actually happened. Then, if basic conditions have not changed, and the employment of a new instrument of warfare against commerce has not fundamentally changed the problem, we may deduce what *history* teaches us to expect as the final result of commerce destroying in the present.

It is clearly understood that discussion of war-history in the making is highly precarious, for data is frequently either purposely withheld or intentionally distorted, and many factors of importance at work in the present can only be clearly seen when their results are viewed as of the past. At the same time it is believed that by waiting, much that may be gained in accurate knowledge may be lost in vital, living interest.

For our purpose it will be necessary to consider the war as between England and Germany only, since Germany is the power

most directly waging war on maritime commerce, and the greater part of that attack is aimed at England.

When war was declared the German Navy found itself inferior to that of England in all parts of the world. Not having the protection afforded by fighting fleets capable of maintaining themselves *at sea*, German maritime commerce practically ceased from the day war was declared, as her ships in all parts of the world scurried to friendly or neutral harbors. At the same time English merchant ships, with but few exceptions, continued their voyages, reassured by the knowledge that in whatever seas they were cruising, the protection of the English fleet followed them, though, of course, not in absolute degree.

As has been done in former wars, the ships of the inferior navy in remote regions turned their attention to commerce destroying. There were seven German commerce destroyers that accomplished enough to entitle them to be taken into consideration, and of these the *Emden* in the Far East and the *Karlsruhe* in the Atlantic were by far the most successful. These ships were handled with boldness, courage and zeal, and yet their claim to distinction is based much more on the romantic appeal of their war careers than on any practical military results accomplished by them.

At first these commerce destroyers inflicted considerable damage on English commerce, but one by one they became entangled in the far flung net of English sea-power, and were destroyed or forced to intern in neutral harbors. During the eight months that it took to account for the seven commerce destroyers, they destroyed between 30 and 35 million dollars worth of English commerce. This is certainly no inconsiderable sum, but after all it is only about seven-tenths of one per cent of England's sea-borne commerce during the same period.

Despite the activities of the seven German cruisers English maritime commerce was never more active. All the necessities of supply from overseas of food-stuffs and other essentials were met, and the effect on the English *military* situation of the German attack on commerce was practically nil. The loss occasioned was almost solely monetary, and, as we have seen, this was not relatively great. In the meantime, all German maritime commerce had ceased, except in the Baltic where from particular circumstances the influence of England's sea power was not effective. Captures of German merchant ships had not been the cause of this cessation,

but the control of the sea, by the English Navy made the certainty of capture sufficient to keep German ships off the high seas.

The great focus of all English commerce is, of course, England, and if an effective attack could be made in English waters it would seem to promise the greatest prospects of producing important results. These waters are very close to German fortified bases, which would tend to increase the effectiveness of war on commerce there, but these factors are largely nullified by the fact that there also is the great concentration of England's sea might. An attack on English commerce in the waters adjacent to England along the usual lines of war on commerce was clearly impracticable. The rich field was there, close at hand, but the problem was to find a way of utilizing this field. Hence it was that Germany evolved her scheme of using submarines in an effort to gather the harvest in the nearby, rich fields where English commerce concentrated, and where it was, more than in any other part of the world, essential to England's military well-being.

Since we are looking at the matter solely as neutrals and from the military point of view only, it is no part of our discussion to inquire into the legality, the humaneness, or the methods of practice employed in the use of this submarine war on commerce, but the effectiveness, the probable results and the wisdom of such warfare are most germane to our subject.

In the early part of the war German submarines were used to attack enemy men-of-war, and considerable success attended their operations, but soon the English fleet learned how to nullify, to a large degree, their effectiveness. For some months thereafter the submarines can hardly be said to have paid for their fuel. Some enterprising submarine commander, in the absence of anything else that he could accomplish, held up and captured a merchant ship, and the seed of submarine war on commerce was planted.

On February 4, 1915, the German Admiralty issued its now famous order which said, among other things:

> The waters around Great Britain and Ireland, including the whole English Channel, are declared a war zone from and after February 18, 1915.
>
> Every enemy merchant ship found in this war zone will be destroyed, even if it is impossible to avert dangers which threaten the crew and passengers.

No mention of submarines was made in this order, but its wording, and the well known naval conditions in the North Sea and

adjacent waters at that time, clearly indicated the character of the war on commerce that Germany was launching. Thus the submarine entered into her rôle of commerce destroyer—a rôle little thought of in her original design or her subsequent development.

It may assist us in our estimate to recall the fact that Germany, when she announced her intention of launching her submarine campaign, did not claim as justification for it that it would be likely to produce important military results, but announced that it was in the nature of reprisal for certain acts on the part of England. Furthermore, it is quite probable that Germany, with her clear understanding of military values, has not expected and does not now expect the results of the campaign to be productive of great military results, though hope may be entertained as to its moral effect both at home and abroad.

It may be well to inquire here if there is any property of submarines that indicates that their use as commerce destroyers changes, to any great degree, the general problem of war on commerce as practiced by various nations for a hundred and fifty years. From a superficial examination it would seem as though such were the case, but upon deeper inquiry the effectiveness of the submarine as a commerce destroyer is found to be much more apparent than real. The ability to submerge is an advantage in that it aids in concealment and protection, but at the same time it enormously decreases vision and speed, both very essential for effective commerce destroying.

On account of the physical limitations of submarines they are easily injured or disarranged and a slight injury or disarrangement may be fatal. Compare the relative effect on a submarine and on a fast cruiser of to-day or a fast frigate of the past, of a shot hole, or a steel net or slight disarrangement in motive power, and the limitations of the submarine as a commerce destroyer are at once apparent. The ease with which she may be damaged even by a merchant vessel, very materially limits her ability to board and determine the character of a suspected vessel, and in even moderately heavy weather she is badly handicapped in every way. The size of crew carried by a submarine makes it impracticable for her to send in prizes under prize crews. She can only destroy her prizes. Thus while she can subtract from the wealth of her enemy, she cannot add to that of her own country. A commerce destroyer has always to keep careful watch for two things—her prey and her

enemies, to capture the one and to evade the other. To enable herself to evade, the submarine has necessarily to reduce her ability to capture. Certainly up to the present the submarine has not demonstrated that it has changed fundamentally, or even in marked degree, the problem of commerce destroying.

The general non-military opinion as to the effectiveness of the submarine as a commerce destroyer is largely due to the fact that submarine exploits have been considered by the newspapers to have great news value and have been featured because the submarine was a new instrument of war, its employment in commerce destroying was unexpected and its humanitarian side gave to it an interest that its military accomplishments did not warrant. It may be pointed out that the reason Germany is using the submarine in her war on commerce is not necessarily or even probably because of a high opinion of its efficiency as a commerce destroyer, but under the circumstances it is the only instrument that she can employ for that purpose.

As to the material results accomplished by submarine commerce destroying it is possible only to approximate roughly, but after reconciling various estimates and remembering that most of them are of British origin, or based upon British data, it is possible to get an outside figure that should cover the loss per month, and it is worthy of note that the rate of loss per month for the last five or six months approximates the average monthly loss for the entire war.

Lloyd's Register for 1915-16 gives the total number of British ships, including colonies, as 11,353, with a tonnage of 21,274,064. The New York *Journal of Commerce* gives as the total British losses for 26 months of war as 874 vessels displacing 1,853,002 tons. Thus approximately 8 per cent of the entire number of British merchant ships, and 8.5 per cent in tonnage has been sunk or destroyed by belligerent operations. The average monthly loss has been just over 71,000 tons. When war began shipping was worth about $45 per ton. Now it is worth three times that. Taking $90 per ton as the average, the loss to British shipping for the first 26 months of the war has been over six millions of dollars per month.

To the above must be added the cargo value. Here there is no exact data available. One British source estimates the cargo loss during the first year of hostilities as only 1 per cent of England's

imports and exports; a total for that year of only 64 million dollars. This seems too low an estimate, yet there seems no way to refute it. Last year 19½ million tons of British shipping (omitting ships owned in British colonies) carried the greater part of 6400 million dollars of England's exports and imports. Thus each ton of shipping carried $328 in commerce *in all of its voyages.* Assuming British ships to average five complete voyages per year, the cargoes lost would total in value only about 55 million dollars, and five voyages per year would seem a conservative average even though British ships seek cargoes far from home. It would seem then that the 1 per cent estimate is after all reasonable. This makes the cargo loss 5½ million dollars per month, and the total direct loss to British shipping under 12 million dollars per month, as an extreme covering figure. This is over a third of a million per day. If viewed alone, the loss of a million dollars every three days seems a big loss, but looked at in conjunction with other things it loses its apparent importance, and if unaccompanied by military factors it may be discounted easily as we shall see.

Each day of war is costing England, according to the most reliable figures, about 28 million dollars, so the loss in maritime commerce is adding to this cost about 1.4 per cent. This loss is financial only. The military loss is impossible to estimate, for no data is available as to what military supplies are being carried on the various ships sunk. We do know, however, that the desire is to so seriously interfere with England's commerce that her military activities will be seriously embarrassed, and that her people will feel the pressure to such an extent as to make them desire peace, even on terms dictated by Germany.

It is a matter of common knowledge that England is getting from overseas an enormous quantity of food stuffs, general supplies and munitions of war, and, since the beginning of the submarine commerce destroying campaign, of those things essential to her military and economic well-being, the quantities received have probably increased rather than decreased. We know further that England is supplying her military forces in a number of places both near and remote. In other words *her lines of communication are intact,* despite the efforts of German submarines. Of course, her lines are not absolutely inviolate, but her losses are relatively small, and they may be cheerfully and philosophically borne as the fortune of war. To whatever extent this form of warfare is

carried, and however many merchant ships England may lose, until and unless her lines of communication are seriously interfered with or threatened, the military effect of the attack on her commerce will be relatively small.

Thus we see that the direct military result of the attack on England's commerce, while not negligible, is of small moment. There remains then only the financial loss. Let us see what economic effect this may have, and, through this, the *indirect* military effect.

England has, for many years, been supported primarily by her overseas commerce, and to cut off her intercourse with other nations is to shatter her economic national life. Furthermore, in the present age England is absolutely dependent upon other countries for much of her food supplies, and very largely dependent upon neutrals for many of her military necessities. For a belligerent to cut off England from outside intercourse is to bring her to terms very quickly. But this is only the statement of the problem; it in no way indicates its solution. It was on account of these very reasons that England maintained her sea power, that she might command the seas. This she has done, and the attacks of submarines is no more than a form of guerrilla warfare—annoying, but not decisive. The fact that Germany's commerce is no more seen, and that England's merchant ships continue to ply their trade upon the seven seas is not changed one mite by the activities of Germany's submarines, but is solely dependent upon the overpowering influence of England's fighting fleet in being.

The monetary loss to English commerce, and thus to England, remains for consideration, and 144 million dollars a year cannot be slightly dismissed, even in this age of enormous financial resources. May not this financial drain upon England in time have appreciable effect upon her military power? Let us see how this loss of shipping reacts upon the national life of England.

When war was declared in August, 1914, England's merchant fleet was worth in round numbers, something over 1000 million dollars. When English sea power automatically swept German commerce from the seas, by forcing it to remain in friendly or neutral harbors, it increased the value of English shipping by certainly 50 per cent. Thus before a real blow was struck, there was added to the value of English shipping an amount equivalent to the losses inflicted by more than three years of submarine

attacks, and this sum was a real income-producer, collected by increased freights the world over. Further than this, each merchant ship destroyed by submarine attack or otherwise, adds to the value of those remaining, and adds to their earning capacity until now England's merchant fleet is worth nearer three than one billion dollars. This remains true of English merchant ships only so long as England has command of the seas, and her ships are enabled to ply their trade without undue risk.

It may be recalled here that the term "command of the sea" does not necessarily mean absolute safety from capture, but such a predominance on the sea that one's undertakings are reasonably secure from an enemy, while enemy undertakings are attended with grave danger. Such command of the sea England now has, and has had since the war began, and Germany's submarine warfare has been no more than a threat to this command. It has by no means changed it.

In this connection it has been stated that by constructing and operating mercantile submarines Germany has overcome or broken England's command of the sea. The absurdity of such a statement need not be pointed out to naval men. The very fact that Germany has been forced to build mercantile submarines in order to get a few hundred tons of freight into and out of Germany is the very highest tribute to England's command of the sea.

Despite the foregoing there is still financial loss to England as a whole through the losses inflicted upon her shipping, but this loss she has means of nullifying so far as it may indirectly affect present military affairs. By one peaceful undertaking she floats an enormous external loan, and recoups herself for the losses she has suffered in a financial way. Thus she avoids the indirect military effect of such financial losses by charging them to the future. Of course, the economic results of these loans on the future may be enormous, but they are outside of our scope, which is to determine the *military* effect of war on commerce. Anything to have military effect must operate in war, and thus financial losses which may be charged to the future are rendered innocuous from the military view point.

In this connection it may be noted that as England in former wars took from France her colonies, one by one, while France was dissipating her naval energy in campaigns against merchant ships, so now she is taking, or has taken, the colonies of Germany. The

English ships sunk by German submarines are lost to the world, but the German colonies taken by England are still factors of great importance, either in making terms of peace or in aiding in the *post bellum* financial rehabilitation of English economic life.

If financial loss be made sufficiently great and sufficiently widespread to bring suffering or extreme deprivation upon many individuals, it may have military effect by damping the general zeal for war or even by arousing a willingness to make great concessions for peace. In the case of the financial losses here considered, we have seen that the very interests that suffer the losses are the ones that to a certain degree have these losses compensated. In this age maritime losses are very generally distributed by means of insurance, and there are no indications of real suffering brought on by maritime losses at sea.

The effect of this form of warfare on the morale of those practicing commerce destroying is, of course, speculative, but it is highly probable that a navy that systematically practices war on defenceless merchant ships almost exclusively for any length of time, will deteriorate in those characteristics that distinguish virile, courageous, manly naval personnel. When the French Navy was for so long practicing direct war on English commerce, the morale of her navy was at its lowest ebb. That this was not racial is at once apparent when we recall that during this same time the morale of the French army was above reproach.

We know that heroic action develops the capacity for heroic action, and the development of military character is very largely dependent upon the nature of the service one is required to render. Some day when fleet meets fleet in a final struggle for supremacy and blows may be parried only by harder blows, the loss that Germany may have to charge up to her war on commerce, may make the loss she has inflicted upon that commerce seem as unimportant as the shadows cast on the waters by passing clouds.

The subject we are investigating has from a naval standpoint, a twofold interest. Primarily as to the effect the type of submarine activity as employed by Germany is having upon the English military situation, and secondarily as to what might have been accomplished by other forms of submarine activity. The latter is speculative, it is true, but a great deal of the art of war is speculative, particularly to those who have not had experience in

actual war, and speculation based upon reasonable premises must always remain one of the chief guides in warfare.

Prior to the Great War it was in the nature of an open secret that in case of an Anglo-German War the type of naval warfare to be used by Germany was to be one of attrition until England's fleet had been brought to such size that the German fleet could meet it with fair chances of success. Submarines and surface torpedo craft were to be the chief instruments in this campaign of attrition. We know that for the first few months of the war this was the type of naval campaign employed by Germany, and not without a considerable degree of success. In the six and a half months of war prior to the inauguration of Germany's submarine campaign against merchant ships, she sunk in the North Sea at least eight men-of-war by submarine attack, whereas since that time in 22 months she has sunk in the same way, so far as we know, only two light cruisers (the *Falmouth* and *Nottingham,* in a fleet contact) and a few torpedo craft. In the battle off Jutland German submarines seem to have accomplished but little. How could they, when they were seeking easier but less important victims far and wide?

In the meantime many submarines were lost while conducting their attacks on commerce. Thus Germany has allowed her submarine power to be frittered away—to be destroyed in detail, contrary to the very principles of warfare of which generally she is so staunch an advocate.

What Germany might have accomplished by her submarines had they been used solely in a campaign of attrition against the English fleet during the last 22 months, no one can say, but one is very safe in saying that the military results of such a campaign would have exceeded those produced by the submarine attacks on shipping.

It would be most interesting could we know for certain what motives impelled Germany in changing her type of submarine campaign. Was her usually clear military judgment clouded by anger? Did she over-rate the results of her attack on commerce, or the actual accomplishments of her flotillas of submarines? Did she think some hitherto unknown peace-compelling property had been added to commerce destroying by the economic developments of recent years? Or was it merely the historic repetition of the lure of an easy mode of naval warfare? With our present knowl-

edge we cannot answer, but from what we know it seems that Germany committed a grievous military error when she diverted her submarines from attacks on naval vessels to attacks on ships of commerce.

Though possibly not strictly within the scope of our inquiry, it may be of interest to note that friction with neutrals is one of the historic corollaries of war on commerce. It is not difficult for one warring on the commerce of an enemy to convince himself that an occasional attack on a neutral will produce results of benefit to his country, and such attack is so *easy,* and resistance so futile. Of course, such attacks may be of use in specific instances, but the resulting resentment of the neutral, if nothing more, is bound to react to the advantage of his enemy, particularly if that neutral is of importance in the family of nations. Especially in this day the good will of neutrals is an asset of considerable importance to a belligerent, and war on commerce is a very likely way of alienating such good will.

What conclusions, based upon antecedent probability and known present results, are we justified in drawing from our inquiry? So far the results of Germany's submarine campaign against commerce have been just about as might have been expected from the known results of commerce destroying in former wars. It has been conducted on no greater scale comparatively than have the other features of this great war, nor has it inflicted damage relatively greater than has been inflicted by some former campaigns against sea-borne commerce. The submarine itself has not changed the fundamental characteristics of this form of warfare, nor imparted to it any peace-compelling property. England is suffering severe monetary loss through submarine attacks on her merchant fleet, but the military effect of this is small, since it is but a small percentage of the expense of war, it is very largely compensated for by the enhanced value of her remaining ships and it may in large part be charged to the economic future through external loans. The English lines of communication for food and other necessary supplies both to England and from England to her oversea armies, have not been impaired to such a degree as to bring undue pressure on her people at home, or to circumscribe seriously her military activities abroad.

It is not sufficient that the *effort* be made to cut off England's lines of overseas communication, to bring her to bankruptcy, to

whilst inflicting upon her people. To be effective these things must actually come to pass, and neither the method, the instrument nor the practice of the present attempt indicates that the great objective will be attained—at least so long as England's fighting fleet bars the way.

Note.—Various naval authors have been consulted in preparing the first part of the above, particularly Mahan, Clowes, Barclay, Corbett and Thursfield.

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"UNRESTRICTED" COMMERCE DESTROYING

By Captain Lyman A. Cotten, U. S. Navy

That it was highly precarious to discuss war-history in the making was clearly understood when the foregoing essay on Commerce Destroying in War was written in the autumn of 1916, and it was so stated therein. This was emphasized a few months later when Germany launched a campaign of commerce destroying not only on a scale much more ambitious than any former campaign against merchant ships, but also having for its purpose a much more important military objective. Now that this campaign is finished, and the war is over, it may be of interest to consider further the subject of commerce destroying in war with the object of ascertaining as far as may be possible what deductions can reasonably be drawn from the operations of the last two years of the Great War, particularly as to how these deductions refute or confirm the conclusions of the former essay, which was written prior to these operations.

Since Germany's war on commerce was aimed chiefly at England, it will simplify our discussion to consider only those two powers except when otherwise stated.

Germany continued her submarine warfare under the terms of her order of February 4, 1915, until February 1, 1917, when she announced that hencefoth she would forcibly prevent all navigation, including neutral and enemy alike, within certain designated extensive sea areas. Within these areas all ships met were to be sunk without further notice.

It is reasonable to suppose that Germany believed that in taking this step in her war on commerce she was injecting into this form of warfare some peace-compelling quality that up to that time it had failed to show, or that this quality which she believed to be inherent in it was in some way to be enhanced. The German

Government, through its representative in Washington, in its note of January 31, 1917, notifying our government of its purpose as to the future conduct of submarine warfare said: "The Imperial Government could not justify before its own conscience, before the German people and before history the neglect of *any*[1] means destined to bring about the end of the war." And in a memorandum accompanying this note said: "The Imperial Government is *confident*[1] that this measure will result in a speedy termination of the war. . . . ." The same belief must have been held very generally in Germany, for many German newspapers expressed the confident belief that the new form of submarine warfare would bring the war to a speedy and victorious conclusion, and some government officials were reported even to have been so lacking in wisdom as to have specified the time within which the submarine campaign was "to impose Germany's victorious will upon a vainglorious enemy."

Let us see wherein the German "unrestricted" war on commerce differed from commerce destroying in former wars, that we may possibly recognize the quality that was thought to have been injected to give it the peace-compelling quality that a study of naval history teaches us had been lacking in these former wars. We find the following six notable features in the campaign:

(1) It was on a vast scale.

(2) It was *concentrated* in certain restricted areas.

(3) It was conducted entirely by submarine vessels.[2]

(4) It was directed against *all* vessels, regardless of character. (Enemy or neutral.)

(5) The nature of the cargo or service of a vessel was not to be determined, nor to have any influence if determined.

(6) Vessels were to be sunk without warning, and consequently without regard for the safety of non-combatants on board.

All of these features tended to facilitate the destruction of seaborne commerce vital to the war-life of the enemies of Germany,

[1] Italics not in original.

[2] Several convoys in the North Sea were attacked by surface vessels, but this was merely incidental to the campaign. The success or failure of the war on commerce rested, of course, solely upon the effectiveness or non-effectiveness of the submarines, so long as England had reasonable command of the surface of the sea.

particularly of England. From this it is not difficult to deduce the military objective of Germany's campaign. This was no attempt to force England into "shameful bankruptcy," as France declared her intention of doing when she concentrated her naval activities on commerce destroying during the French Revolution, but was a carefully planned campaign to take from her the military asset (recognized by everyone as essential) of overseas *commercial* intercourse; to take it from her to so great a degree that she would be brought to such a state of impotence as to consider it the part of wisdom to submit to the will of her enemy. In other words, Germany attempted to find a *partial* substitute for command of the sea in certain areas, that she might take from England a part of what the British Navy had taken and was still holding from Germany, that is, profitable use of the surface of the sea for overseas communication. It made no difference in its results whether this use was by neutral or enemy vessels so long as it resulted in military profit to England.

This is beyond question a new idea in the use of commerce destroying in war and is directly traceable to the perfection of the submarine coupled with the willingness of the Germans to use this weapon in an illegal and inhuman way. In former wars on the sea commerce destroyers, as distinct from fighting ships, having of necessity to move in the same plane as fighting men-of-war, could not, and, so far as a reading of naval history reveals, did not at any time attempt to deny of themselves to an enemy overseas commercial intercourse. The power to do this went with command of the sea and this being but a result of fighting sea power could not be challenged seriously by commerce destroyers, though they might carry on intermittently and in certain areas their war on the commerce of their enemy.

Command of the sea has meant that one having that command could use the sea with reasonable safety, and at the same time could forbid its use in like degree by an enemy. It implied two powers, the power to use and the power to deny. That was before vessels could operate beneath the sea, and must now be qualified to a certain extent. Germany attempted by her submarine campaign on merchant vessels to deny to her enemy the use of the sea for commercial intercourse, without in any way acquiring for herself such use. It was in no way an attempt to wrest command of the sea from England, but it had for its aim the taking away of only

part of the benefits of such command, which in this case was thought to be a vital part.

The submarine campaign launched on February 1, 1917, was not aimed at England's sea power, through which she exercised command of the sea and denied beneficial use of the sea to Germany; it was aimed at merchant vessels, enemy and neutral, who were engaged in profitable service for England, which, of course, had been made possible by British sea power. It was in the form of an acknowledgment that that sea power itself could not be challenged with reasonable hope of success, and therefore attempt would be made only against part of the benefits of England's command.

Not only did the six notable features of Germany's "unrestricted" submarine warfare tend to facilitate the destruction of merchant vessels engaged in commerce of vital importance to the war-life of her enemy, but the last three were doubtless intended to have another effect on that commerce. The military objective was not the destruction of ships *per se* but the destruction of commerce useful to the enemy. If ships could be made by other means to refrain from taking part in this commerce, the objective was attained so far as these ships were concerned.

The last three features noted violated international law as affecting both enemies and neutrals, and offended against the standards of modern civilization and the most elementary principles of humanity. These features, interpreted through their application by the Germans and in the light of their past conduct afloat and ashore, may best be characterized as constituting a violent form of terrorism. Doubtless the German authorities thought that this terrorism would effectively and permanently prevent a large number of neutral vessels, and possibly some enemy vessels, from taking part in the commerce that it was desired to destroy. In this particular the Germans certainly injected into commerce destroying a new feature, but one that offends against world-standards to such an extent that it is of little naval interest to study it, except as showing how far one may descend when the lust for success overshadows all else, and even honor and every element of decency is not thought too great a price to pay for it. Surely the German Government did not exaggerate when it intimated to our government that it would not neglect *any* means that it thought would bring success.

The naval problem that confronted the German authorities in the autumn of 1916, in so far as it relates to the subject under consideration, was this:

> England through her command of the sea was preventing Germany from using the sea for commercial intercourse, thus demonstrating to her as no pre-war academic argument could do one of the values of sea power.
>
> At the same time England was herself enjoying all the benefits of overseas commerce that she was denying to Germany.
>
> Germany could not with reasonable hope of success challenge the sea power of England.
>
> If the benefits of overseas commerce could be taken from England she would be vitally injured, as Germany could deduce from the object lesson of Germany herself.
>
> Germany had certain vessels that could operate against merchant ships with a fair degree of immunity from England's fighting ships, *under certain conditions.*
>
> To solve this problem required:
>
> (a) A large number of submarines.
> This she had, and more were building.
>
> (b) Concentration.
> This she could control.
>
> (c) A reasonable degree of immunity for her submarines.
> This she could only hope to get by using them in an illegal and inhuman war. This she did.

Thus we may say that after all the only new element in Germany's final war on commerce was terrorism. It was not the submarine that made this campaign so dangerous, but the inhuman way in which it was used. It is but a manifestation, so often shown by Germany, that a desired end justifies *any* means. Working under this premise it must be admitted that the "unrestricted" submarine campaign of Germany gave promise of solving satisfactorily the problem under consideration, *looking at that problem solely as it existed at that time, and not taking into consideration the changes that would be made in the problem by reason of the very agency that attempted its solution.*

In this respect Germany's decision may reasonably be compared with her decision to invade France by way of Belgium. As the problem existed *before a solution was undertaken,* there is little

doubt but that the easiest way lay through Belgium. But the very attempt changed conditions by bringing Belgium into the war against Germany, by precipitating England's decision to enter the war, and by alienating very largely the good will of the neutral world. All of these changes, of course, increased the difficulties of the German problem as it had existed prior to the invasion of Belgium.

In attempting to solve to her own satisfaction the problem of England's overseas commerce by injecting the element of frightfulness (illegal and inhuman practices) into her campaign, Germany not only set in motion counter-influences to make that problem more difficult, but also, as we shall see, brought in new factors in other fields of war activity that worked to her very serious detriment in her effort to win the war.

Having looked into the nature of the German problem and having seen the means and method by which she attempted to solve it, we may now consider the results, which in war is the final criterion.

The mere announcement that Germany was going to indulge unrestrictedly in her well-known capacity for frightfulness on the sea, produced certain results favorable to the attainment of her objective. *Neutral* sea-borne trade in and adjacent to the sea areas surrounding her enemies was disorganized, and, for a time, very nearly stopped entirely. Merchant vessels of her enemies, however, continued to carry on as before, recognizing that their duty was too vital to the Allies to be interfered with by anything less than physical stoppage, and taking the increased dangers and frightfulness as unavoidable parts of their burden of war.

The effect of the practical cessation of neutral overseas commerce in European waters was serious on the Allied cause, for Allied merchant vessels had been materially reduced during the first two years of war. Had this cessation been permanent it might have had a deciding influence on the outcome of the war, but it was only temporary, as might have been foreseen. In war attempted commercial suppression automatically sets in motion counter-agencies which tend to off-set the suppressive measure. Thus, a blockade according to its degree of effectiveness by increasing the reward for running the blockade, automatically induces the more frequent attempt to do so. The threat of capture is not effective itself, even though capture may be attended by

dire results; the chances of success must be reduced below the point of possible adequate reward for success. In a revolution-infested country, though the penalty of capture at "gun running" may be death, still it will be undertaken so long as the chances of success are such as a human being will accept and adequate rewards of success are forthcoming. To be effective a suppressive measure must be positively so, and not dependent upon collateral influences.

German frightfulness in her "unrestricted" submarine warfare, being at once recognized as a deterrent upon neutral commerce useful to the Allies, caused a further rise in freight rates, and increased liberality in government insurance. At the same time such additional safeguards as the Allied navies could give were given, and from the results of voyages actually made into the "barred" zones it was seen that the chances of success were not prohibitive when the rewards for success were considered. Under these conditions neutral commerce was soon induced to resume its war trade. Thus frightfulness as a deterrent factor was largely counterbalanced by economic adjustments, these adjustments, of course, being borne by the Allies in the way of higher freight rates, increased insurance losses, and curtailed consumption.

This still left the problem of intensified destruction of merchant ships, both belligerent and neutral, to be countered. There is no question but that this problem was for some time a very serious one. During the first three months of "unrestricted" submarine warfare over two million tons of shipping were sunk, and the curve of destruction was still ascending. In the third month alone approximately 875,000 tons were sunk. The attainment of Germany's objective was only a matter of arithmetical calculation if she could keep up her attained rate of sinkings and if no new construction was completed to replace the ships sunk.

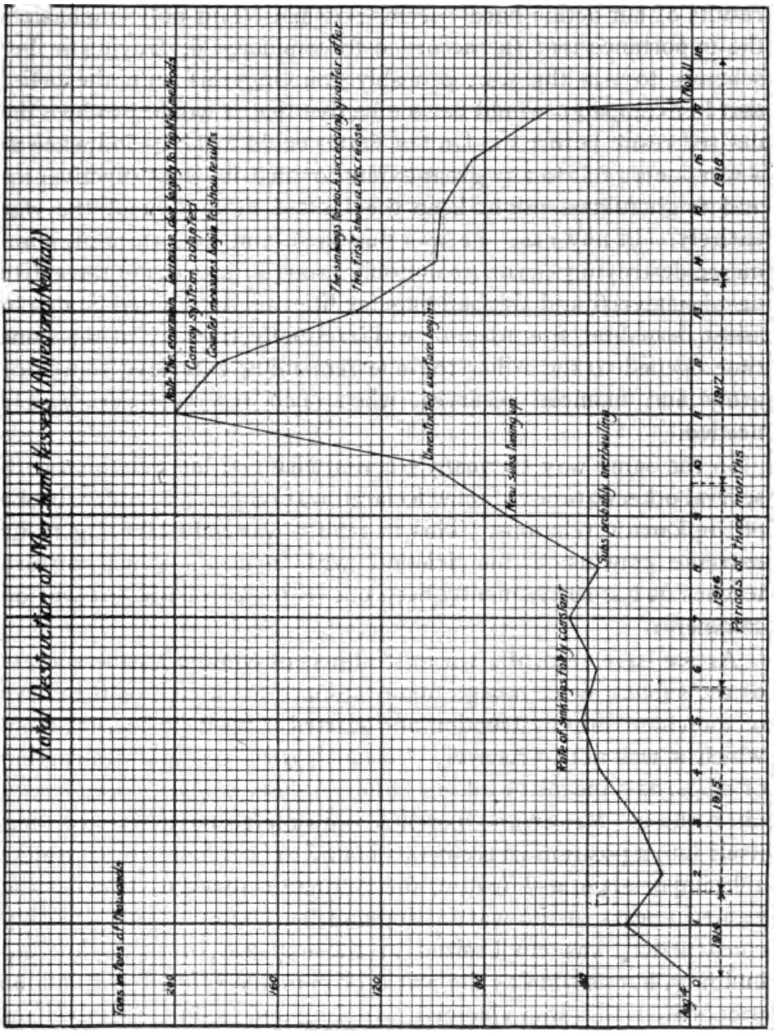
In waging war it may be accepted as a truism that any new agency or method employed will cause the development of counter measures, and to attain its object a new thing employed must command success before the counter measures become effective. This the "unrestricted" submarine warfare did not do, though it came near enough to it to make one seriously wonder if frightfulness was not going to produce material dividends of large proportions, whatever might be its moral quality.

That the illegal and inhuman way in which the submarine warfare was conducted added enormously to its effectiveness there can be no question. It was, no doubt, adopted primarily for that reason, its deterring effect on neutrals probably always being recognized as secondary. The sinkings by submarines began to increase quite markedly several months before the beginning of the "unrestricted" campaign. This was in all likelihood due to the increased number of submarines being made ready for the new campaign. Any way the first three months of "unrestricted" warfare produced an increase in sinkings over the preceding quarter year of almost exactly 100 per cent, though the sinkings for the former quarter were themselves much in excess of those of any other like period prior to that time.

It, of course, takes time for counter measures to develop, and this is particularly true as to measures to counter illegal and inhuman practices that right-minded men considered as beyond the pale under modern standards. Apparently the counter measures began to be increasingly effective after the first three months. The curve below shows the total tonnage sunk by quarter years for the entire war, that the effects of "frightfulness" and counter measures may be seen at a glance.

The counter measures adopted are so generally known that they need no extensive comment, but it is interesting to note that they really involved no new principles, though new devices were employed. Some of the counter measures were defensive and some offensive. They included, in general terms, increased employment of anti-submarine vessels, anchored mines, and air patrols, the adoption of the convoy system, and the development of special weapons of offence and of submarine detection devices.

In the meantime the method of warring upon commerce adopted by Germany had produced one very important and concrete result, not only vastly increasing her difficulty in pressing this warfare to a successful conclusion, but also adding materially to the burden of her efforts in other fields. On April 6, 1917, the United States declared war on Germany as a direct consequence of her ruthless submarine warfare. However probable it may be that the United States would have entered the war against Germany at some later date in any case, it can hardly be denied that she was actually brought in by Germany's action based on the


Total Destruction of Merchant Vessels (Allied and Neutral)
Tons in Tens of Thousands
200
160
120
80
40
Convoy system adopted
Counter measures begin to show results
The sinkings for each succeeding quarter after the first show a decrease
Unrestricted warfare begins
New subs turning up
Subs probably overhauling
Rate of sinkings fairly constant
Nov. 11
1914
1915
1916
1917
1918
Periods of three months

fallacious belief that she could win the war by commerce destroying as it was to be practiced by her.

That Germany could not have foreseen this as one of the possible results of her action hardly seems possible. This only emphasizes the importance that she accorded to commerce destroying in her schemes to win the war, probably coupling this with the belief that her campaign would be so effective that it would produce the desired result before the United States could make its influence as a war factor felt to any great extent, or that its very effectiveness and frightfulness might keep the United States out of the war entirely. In any case she was mistaken, and thus through commerce destroying Germany not only brought into action the entire naval, material and shipbuilding facilities of the United States to assist in making this form of warfare ineffective, but at the same time opened to the Allies the one remaining extensive source of army and financial reserves, when such reserves were sorely needed.

In the same way Germany's action changed her relations with several other nations. Some declared war on her, and others broke off diplomatic relations. This in reality was only carrying to its extreme conclusion the friction with neutrals which history teaches us has so frequently been one of the corollaries of war on commerce.

As we have seen, the various influences counter to the success of the submarine campaign finally stopped the ascent of the curve of merchant ship destruction and started it upon its descent from which it was not to recover. So much for the actual destruction of ships, as a means of taking from England overseas commercial intercourse. Meanwhile merchant-ship replacement was working itself into a position where it was bound to be a factor of considerable importance in defeating the German campaign. During the first two years of the war in England the importance of war-ship construction was emphasized at the expense of merchant-ship building, but as soon as the war on commerce reached formidable proportions this was changed. In England additional merchant ships were laid down, and in the United States an enormous building program was started. It is one of the weaknesses of war against an industrial element that industrial resources can be brought to its aid with great facility and these can act far from the fields of actual combat. When through the offensive and defensive

measures adopted and the new construction undertaken the curve of destruction dipped under the curve of replacement, war on commerce as a means of bringing victory to Germany could be definitely characterized as having failed.

It is interesting to note that even when the submarine warfare was attaining its greatest degree of success, and despite the element of terrorism injected into it, the overseas commerce of the Allies continued to function without ceasing for as much as one day. In the meantime, of course, the sea was not made one whit safer for German sea commerce by her campaign against the commerce of her enemies, and, just as it had been from the beginning of the war, German merchant ships remained off the high seas. This indeed is one of the inherent weaknesses of direct war on commerce. It is an attempt to deny to an enemy the use of the sea for a particular purpose but not for other purposes, without in any way adding to the facility with which it may be used by one's own vessels. This was doubtless recognized by Germany before she decided to undertake this form of warfare in the way she did, but, since she could not hope to challenge successfully England's command of the sea she was willing to attempt something less. To deprive England of even a part of the benefits to her of command of the sea was recognized as important enough to warrant the attempt on a large scale, even though other powers might thereby be brought into the war as enemies, and even though practices had to be adopted that would make the German Navy a stench in the nostrils of civilization.

The most interesting thing that we note from Germany's vast campaign of commerce destroying is that despite the scale upon which it was conducted, notwithstanding that it was conducted generally in accordance with the sound military principle of concentration and even though it employed the added element of frightfulness, it was none the less associated with defeat, just as all former campaigns of direct commerce destroying have been. In this case it is not only interesting, but highly satisfactory that such was the case.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

DESIGN AND CONSTRUCTION OF THE *NC* FLYING BOATS

By COMMANDER G. C. WESTERVELT, C. C., U. S. Navy

In June, 1917, two months after the entry of the United States into the World War, no definite air policy or program had been adopted by this country. This condition was due to the lack of any conclusive information regarding the work of the Allied Governments along these lines, and to varied and contradictory recommendations which had been received from the War Departments and the Admiralties of Great Britain and France as to the types of planes which should be adopted by this country. To remedy this condition an informal joint Army and Navy Board was appointed to proceed to Europe and to make a study of air matters among the principal governments engaged in the war against Germany, and to recommend the steps to be taken by our government in building up its own air services and in carrying out a definite air policy.

The personnel of this committee was Major R. C. Bolling, Captain V. C. Clark, Captain E. S. Gorrell, Captain Howard Marmon and Captain Hughes representing the army, and Lieutenant W. G. Child and the writer representing the navy. In accordance with instructions to the committee, they proceeded to Europe, arriving in London the latter part of June. At this time, the naval activities of the U. S. Government were directed mainly against the submarines. The center of naval activities was the American Embassy in London, and by this time the naval officers had become keenly aware of the grave menace of the German submarines. At the embassy all discussions centered around this subject, and it was evident that fuller methods of combating the submarine must be provided and provided very

quickly. Accordingly, we began a particular and detailed study of the types of aircraft for use against the submarine menace. This study was carried on in England, in France, and in Italy, and, as a result of this study, it was concluded that the quickest way for the navy to obtain results in the air would be with kite balloons, for observation purposes, anchored to a destroyer or some other type of patrol vessel, and with seaplanes of the flying boat type, as differentiated from the hydroaeroplane, for patrol purposes and for the bombing of submarines.

At this time, the largest flying boat in use for patrol work was the *H-12*, a craft equipped with two Rolls-Royce motors, with a lifting capacity of approximately 9000 lbs., and a cruising radius of slightly over 500 miles. This type of boat had proved successful in patrol work, except for its limited cruising radius. Because of the fact that the regions in which submarines were active were often a considerable distance from the naval air bases, the entire time available for patrol was often used in flying to and from a base. It was very desirable that larger craft should be provided, craft which could not only carry a heavy load of bombs, but which also had sufficient radius of flight for the trip from the naval bases to the patrol regions and return.

The writer returned to this country on September 1, 1917, and on September 2 reported the results of the investigations to Rear Admiral D. W. Taylor, the Chief of the Bureau of Construction and Repair. Admiral Taylor had been much interested in the work of the larger flying boats, and his parting injunction to the writer before his departure for Europe was to examine carefully the work being done along the line of flying craft much larger even than any then in use. When the report with its recommendations had been presented to Admiral Taylor, he immediately went far beyond any recommendations which had been made, and ordered the design of a flying boat able to fly itself, if possible, across the ocean. This would mean the capacity to proceed before daylight from a seaplane base to the patrol area, to spend the day in patrol work or in convoy, and to return to its base after dark. In addition to this, it must be able to carry several bombs of a size sufficient to increase very materially over the possibilities of that day the danger zone in the bombing of submarines.

All the information made available regarding the design and construction of flying boats of great size indicated the enormous

difficulty of such a project. The trend of opinion of the European air ministries was against such large sizes, and, as far as the methods of construction and the motor powers available at that time were concerned, the limit of size had been practically reached. On the presentation of these facts to Admiral Taylor, and the pointing out to him of the possibility of failure of such a project, he declined absolutely to be interested in this phase of the problem, and in his characteristic manner closed the discussion he was having with Naval Constructor Hunsaker, head of the Construction and Repair Aeronautical Section, and the writer, with instructions to "get busy and produce results."

This was the inception of the design of the *NC* type of flying boats. After a conference between Naval Constructor Hunsaker and the writer, it was decided to call upon Mr. Glenn Curtiss, at that time the American most experienced in the design and construction of seaplanes, for his suggestions as to the type of seaplane which might best fulfil the requirements. In obedience to a request from Admiral Taylor, Mr. Curtiss came to Washington, and, in a conference between the naval officers above referred to and himself, it was decided to give consideration to the possibilities of a seaplane capable of sustained flight from Newfoundland to Ireland, if possible, or at least capable of flight from Newfoundland to the Azores. Certain definite conclusions reached by the bureau regarding the probable type of such a seaplane were given Mr. Curtiss for his examination.

Within a few days after this conference, Mr. Curtiss returned to Washington with preliminary plans for two types of flying boats, embodying in their general characteristics the conclusions of the bureau—one a five motor 1700 horsepower machine, and the other a three motor 1000 horsepower machine. Both were biplanes, similar in design, and differing only in size, the size being dependent upon the available horsepower. The hulls of these machines differed greatly from the conventional design. They were much shorter than the conventional boat hull, were shaped more like the pontoon of a seaplane, and with the intention that the tail surfaces instead of being supported by the hull would be carried by a system of outriggers in part from the upper wing beams, and in part from the stern of the hull. These suggestions covered rough sketches only of the proposed machines, together with certain estimates based on extensive experience as to weights

and sizes. Admiral Taylor was in favor of the larger boat. The writer, however, due to his experience in airplane construction, his familiarity with the limitations in manufacturing facilities, and because of the small experience of our designers, and of uncertainties regarding the availability of suitable engines, argued in favor of the smaller craft. The final decision was to not attempt the construction of the larger size of 1700 horsepower but to stick to a smaller one of approximately 1000 horsepower.

In taking up the design of such a seaplane, it was very evident that radical changes in the method of design must be followed. With the methods of design at the time almost generally employed, the limits of size had been practically reached. The largest machine at that time in use was the Handley-Page night bomber. In the design of this airplane new and advanced methods had been employed, and to its study much consideration was given. This machine had a total lifting capacity of 11,000 lbs. and was equipped with two 275-horsepower Rolls-Royce motors. The dead weight was approximately 6600 lbs., and the allowable weight for oil, gasoline, cooling water, crew and miscellaneous supplies, which grouped together are called by the name of "useful load," was 4400 lbs. This made the value of the useful load 40 per cent of the gross load, which was the maximum percentage which had been obtained in any large machine. Naval Constructor Hunsaker in estimates which had been made of various planes of an average lifting capacity of 2500 lbs. had found that the percentage useful load was from 30 to 32 per cent. The proposed design for the 1000-horsepower flying boat called for a total load of approximately 25,000 lbs. In comparing this machine with the Handley-Page night bomber, it was apparent that the design of the Handley-Page would have to be improved upon and the percentage of the useful load made at least as high if this design was to be considered successful. One possibility of improvement of the design was in the use of the Liberty motor which was at that time undergoing its first tests, and which gave promise of being lighter for its power that any other motor then in use.

It has been found in the design and construction of large airplanes and seaplanes that the unescapable dead weights, such as engines, propellers, radiators, gasoline and oil tanks, crew, etc. which must be allowed for, require, in a completed plane which will carry them successfully, a total weight of, roughly, from three to

four times the sum of these dead weights. If in any manner, such, for example, as by a reduction of the weight per horsepower of the motor, 100 lbs. can be saved in the weight of any of these parts, there can be a reduction in the total flying weight of the machine of from 300 to 400 lbs. or else a considerable increase in the weight of gasoline which can be carried. There were also possibilities of reduction in weight of structural elements, such as wing beams, ribs, wing struts, compression struts, fittings, etc. If by any method of design it were possible to reduce the weights of these parts without reducing their strength, there would again be a gain in the fuel carrying capacity of the machine over that possible with methods of construction at that time in use.

The points outlined above give some idea of the problem of design which it would have been necessary for the Bureau of Construction and Repair to handle in the preparation of plans for this boat. Because of the insufficient technical force at the bureau, and the difficulty in increasing this force, it was decided that the best method of procedure would be to transfer the physical work of the design of this machine to the Curtiss Aeroplane and Motor Corporation at Buffalo. The Curtiss Aeroplane and Motor Corporation was the only aeronautical manufacturing company which had a well organized design force in any way capable of handling this problem. On the transfer of this design to the Curtiss organization, it was intended that the navy would exercise close control over the design, and that the Curtiss organization should work out all details under navy supervision.

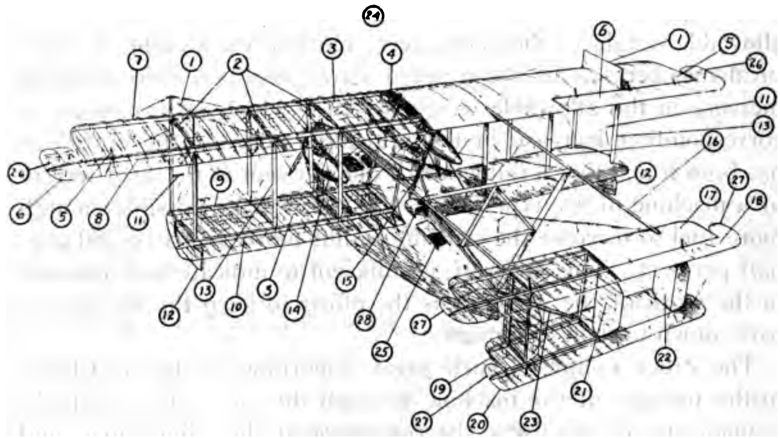
When plans for the design had been carried this far, it became necessary for Admiral Taylor to obtain the cooperation of the other bureaus which would be concerned in the construction of such a craft, and to obtain the approval of the Secretary of the Navy. The Division of Operations and the Bureau of Steam Engineering agreed to the carrying out of these plans, and the entire proposition was then submitted to the Secretary of the Navy. The secretary approved the proposal which had been made, and it was then possible to proceed upon the definite work of design. Accordingly, a contract was made with the Curtiss Aeroplane and Motor Corporation on the basis of cost plus a fixed profit on the determined cost. Such a contract was necessary because no design similar in nature to this had even been attempted, and there

were no figures available which could give even an approximate estimate of the cost of such a design. The contract as arranged provided that all labor and material should be charged directly to the contract. To this charge 100 per cent would be added to cover intangible and indirect expenses which could not be definitely estimated; and, to the sum of these two amounts, 10 per cent was to be added for profit. This proposed contract was satisfactory to both the navy and the Curtiss Aeroplane and Motor Corporation, and work was started upon the design early in October, 1917. The design work was later transferred to the Curtiss Engineering Corporation at Garden City, Long Island, where it was completed in January, 1918.

At this time it became necessary to choose a name for this type of flying boat. Inasmuch as the design work was under the supervision of the navy but was being carried out by the Curtiss organization, it was decided that the name of the type would be the *NC-1*, *N* standing for navy and *C* for Curtiss, and the *1* representing the first boat designed under this arrangement between the navy and the Curtiss Company. It was intended calling specific boats of this type *NC-1*, No.1, *NC-1*, No. 2, etc., but as this has proven awkward in use the type is now known as the *NC* type, and the specific boats as the *NC-1*, *NC-2*, etc.

The method usually followed until a year or two ago in the production of new types of flying boats, and for new types of airplanes in general, had been to make sketches of the proposed type of plane and of some of the more important elements and details, estimate the probable weight, and then to proceed immediately upon the construction of parts. If the completed machine did not give satisfactory operating characteristics, certain parts would be changed and it would be tried again. This method would be continued until the design proved to be entirely unsuited for practical use or some satisfactory compromise was reached. With such an unscientific method of design it is exceedingly difficult to determine why a plane fails to come up to the estimated performance. If the weights are excessive, it is difficult, or even impossible, to determine wherein the excess lies, or how to change the construction to make a reduction. If the speed of the machine fails to come up to expectations, it is practically impossible to determine what changes can be made.

In the design discussed, due to the great increase in size over any successful boat previously constructed, and to the necessity of increasing the percentage of useful load above any which had been reached in flying boats, the adoption of the method of procedure as outlined above would have made failure certain. It was determined to have every detail designed carefully, according to



DIAGRAMMATIC SKETCH OF "NC-4."

1. Non-skid Fin.
2. Compression Struts.
3. Wing Ribs.
4. Gravity Tank.
5. Aileron Horn.
6. Aileron.
7. Forward Beam—Upper Panel.
8. Rear Beam—Upper Panel.
9. Forward Beam—Lower Panel.
10. Rear Beam—Lower Panel.
11. King Post Brace—Outer Struts.
12. Wing Tip Pontoon.
13. Wing Struts.
14. Outer Nacelle.
15. Pusher Propeller.
16. Outrigger.
17. Upper Horizontal Stabilizer.
18. Upper Elevator.
19. Lower Horizontal Stabilizer.
20. Lower Elevator.
21. Balanced Rudder.
22. Vertical Stabilizer.
23. Tail Boom.
24. Pilots' Seats.
25. After Hatchway.
26. Balancing Section—Ailerons.
27. Balancing Section—Elevators.
28. Aluminum Shield under Pusher Propeller.

the best engineering practice, and to have the design practically completed before any construction work was commenced. It was only in this way that it would be possible to arrive at a design which would give a practical certainty of a flying boat coming up to the requirements laid down by Admiral Taylor, or which failing in this would show definitely and exactly to what failure was due.

In the design of any type of airplane two factors are of major importance. One of these factors is weight. The relation between weight, effective lifting surface, and the speed of flight, may be expressed by means of an equation, $L = K_y AV^2$, where L represents the total weight in pounds, A is the total effective area of all supporting surfaces expressed in square feet, V is the speed expressed in miles per hour, and K_y is a constant depending for its value upon the construction of the machine. For any total allowable weight of the plane, every reduction in weight of structural members, as has been noted above, means a corresponding increase in the allowable weight of fuel, which in turn means a corresponding increase in the cruising radius of the craft. It has been found that a reduction of one per cent in the dead weight of a machine of the type of the *NC-1* will make possible enough more fuel to increase the cruising radius more than two and one-half per cent. This, in itself, is sufficient to indicate how valuable in the work of the designer is the effort to keep the weights of parts down to their minimum.

The other factor of such great importance is the resistance to the passage of the machine through the air. This resistance is made up of two parts, the resistance of the wing panels and control surfaces, and the resistance of other parts, such as wires and cables, wing struts, nacelles, boat hulls, etc. The resistance of a wing panel has a certain very definite value for each type of wing surface, and has been very accurately determined for all the different types of wing sections. The other resistances, which are grouped together under the general term of "parasite" resistance, must be calculated for each separate part, taking into account the size and length of the part, and its position with respect to the direction of motion. From tests which have been made, the values of coefficients for use in calculating these resistances have been very accurately determined, and the total resistance or "drag," which is the term used to represent the combination of wing panels and parasite resistances, may be calculated. The resistance for any individual part may be expressed by means of an equation similar to the one used above for the total lift or weight. This equation may be written $D = K_x AV^2$, where D represents resistance expressed in pounds, V is the velocity of motion in miles per hour, A represents an effective area of all parts producing the resistance and K_x is the co-efficient referred to above. The total drag

is the summation of these resistances, plus the wing panel resistances. The horsepower required to move the plane through the air at a given speed is then determined from the expression: Horsepower $= \frac{\text{Drag} \times \text{velocity}}{375 \times \text{eff.}}$; where drag is the total drag in pounds as calculated above, velocity is expressed in miles per hour and efficiency is the propeller efficiency, which in turn depends upon the velocity and the revolutions per minute of the propeller.

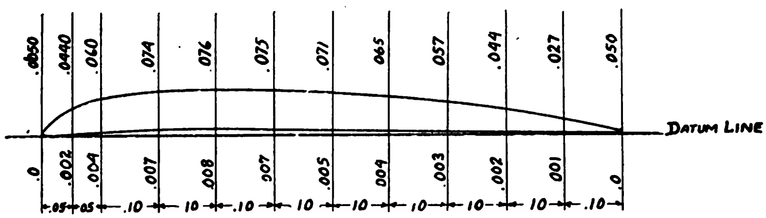
The original plans discussed with the representatives of the Curtiss organization called for the design of a flying boat capable, if possible, of sustained flight from Newfoundland to Ireland. As soon as the design had progressed far enough, accurate calculations of weights and resistances were made. Upon the completion of these calculations, it was found that although the total weight came within the specified limits of 25,000 lbs., the total resistance was so high that, with the horsepower available, the speed would be cut down to such a low value that the estimated cruising radius instead of being the 2000 miles required for going from Newfoundland to Ireland, would be not more than 1300 miles. There seemed to be no possible way by which the amount of this resistance could be reduced and, because of this fact, the design of a flying boat capable of flying from Newfoundland to Ireland had to be abandoned as impracticable, temporarily at least. The design was now taken up on the basis of a total weight of 22,000 lbs. and a cruising radius of 1300 miles.

It would have been possible at this time to take up in detail calculations for a five-motored flying boat, as previously suggested by Mr. Curtiss. Difficulties which had been met with in the design of the three-motored craft had shown, however, that the original decision regarding size and horsepower had been wisely made and that it was better to continue the work with the three-motored type of craft, even though its cruising radius were limited to 1300 miles.

It was necessary to carry on a considerable number of very complete investigations to determine the sizes and shapes of parts to be used in the construction and the materials of which these parts should be made. These investigations had to do with the choice of wing beams, wing struts, wing ribs, compression struts, metal fittings, outriggers for the tail support, and various other parts to be used in the construction of the hull and tail surfaces.

Before a choice of materials to be used in the manufacture of the parts of the wing panels could be made, it was necessary to determine the shape of the wing panel section to be used in the construction. After consideration of various sections, it was decided to make use of the wing section known as the R. A. F. 6, a section designed and used extensively by the Royal Aircraft Factory of Great Britain. This section has a good lift factor, and the lift-drag ratio, which represents the efficiency of the section, is high. Another factor which determined the choice of this section was the depth of the section itself. Due to the large span of the proposed seaplane, the wing beams must, of necessity, be of considerable depth to give the necessary strength, and, inasmuch as

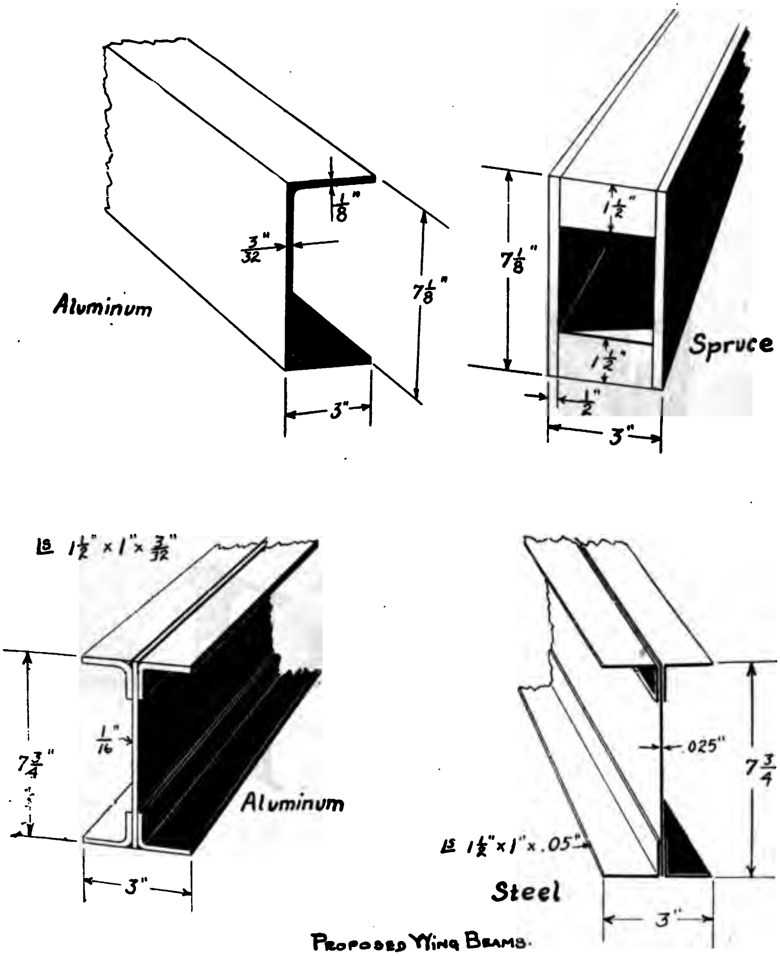
RAF-6 AIRFOIL SECTION



the beams are enclosed within the wing structure, it was necessary to have a wing structure which in itself had the requisite depth.

In the choice of the wing beams to be used, beams built of steel, aluminum and spruce, of various cross sections, were investigated. The more important types of these beams are shown in the accompanying sketches. The total depth of the beam was to be approximately 10 inches; the total length of the beam in the upper outer panels was to be approximately 45 feet; and it was required to carry a load of 190 lbs. per running foot. As the final choice, to meet these requirements, a spruce beam built up in the form of a box was selected as the one which would be most satisfactory in construction and in operation. This choice was based upon weight for a given strength, upon availability and dependability of material to be used in construction, upon ease of construction, and upon the stiffness of the beam for the required depth.

In the choice of wing ribs, ribs built up of aluminum, of steel and of spruce were considered. Based upon weight alone, the choice would lie with the aluminum rib. Weight, however, is

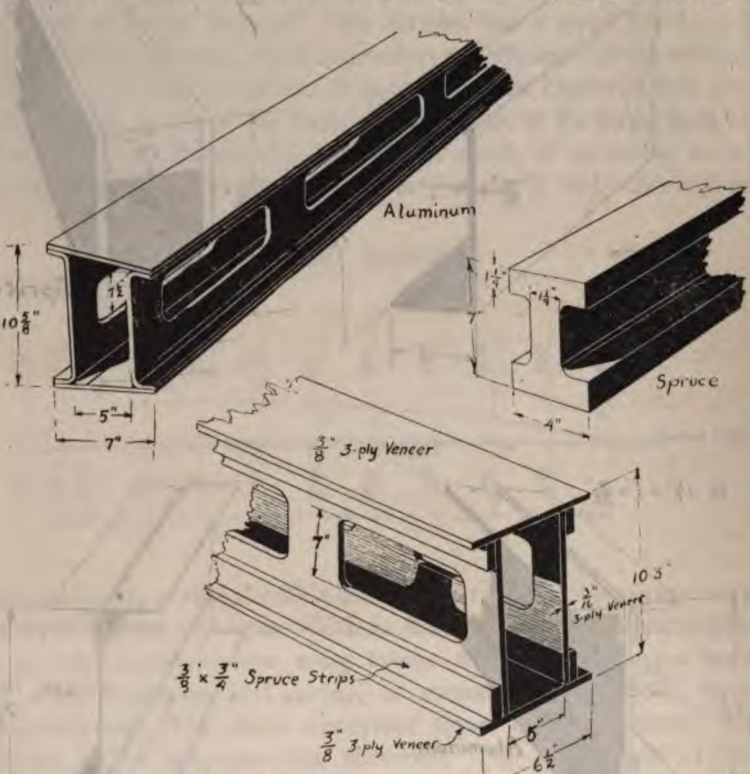


PROPOSED WING BEAMS.

not the only factor which must be considered in the choice of the wing rib to be used. With aluminum, there would be danger of deterioration due to the effect of moisture; there would be great difficulty in making satisfactory connection of the several parts of the rib structure; and there would be difficulty in obtaining alumi-

num which could be depended upon as uniform in structure and in strength. For these reasons, the use of aluminum for construction of wing ribs, as well as for construction of other strength parts of the machine, was decided against.

The second choice on a weight for strength basis of material to be used in the construction of the wing ribs was spruce. Due to



PROPOSED WING BEAMS.

the depth of the wing section, and due to the chord of 12 feet, the best construction seemed to be one in which the rib was built up of spruce capstrips, used to form the upper and lower surfaces, joined together by means of small vertical and diagonal spruce members arranged in the form of a truss construction. This construction is very similar to that of the Handley-Page rib, which it had been the writer's good fortune to be able to examine during the trip to Europe which has been mentioned previously.

In this rib great importance attaches to one of the constructional features. At all joints between the vertical and diagonal truss members and the capstrips, a linen wrapping is used. It is fastened to the spruce members by means of Keystone glue; causes them all to act in unison; and produces a most appreciable increase in strength and in reliability. Actual tests have shown that the use of the linen wrappings practically doubles the strength of the rib.

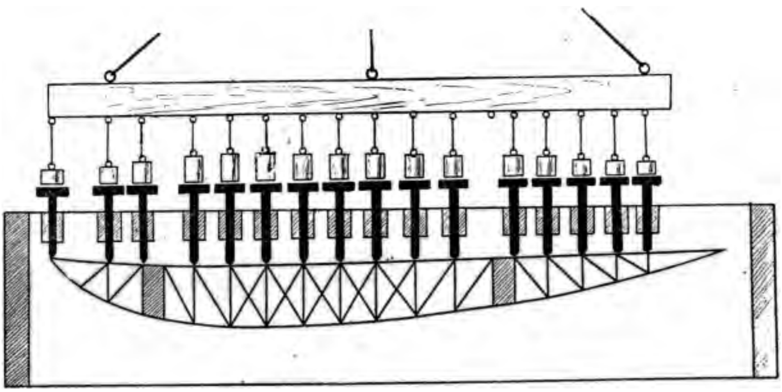
Before the exact type of rib and the sizes of the parts were decided several sample ribs were built up and tested. The method of testing, and the machine used in supporting the rib during the

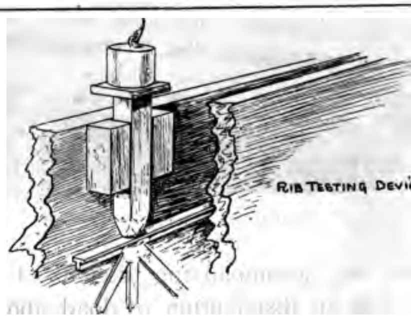
"NC-4" Assembly of Rib to Beam.

test, are shown in the accompanying sketch. For each wing curve there is a definite distribution of load above and below the wing panel from the leading edge to the trailing edge. By proper distribution of this load along the rib, weights may be determined which will represent the loads acting at the joints of the truss members and these weights may be so calculated as to give these members their normal loading or any desired excess loading. In the tests made, as in the design of all parts of the machine, except wires, it was assumed that a factor of safety of four would be required.

In the design of the compression struts, it was assumed that these struts would have to carry a total flying load equal to approximately

one-third of the total weight of the machine, or, in round numbers, 7000 lbs. In the investigations made to determine the most desirable compression strut, it was found that aluminum with a circular section was the lightest for a given strength, but because of the reasons stated above, the aluminum was not chosen. The next most desirable strut was a spruce strut of a circular cross section, tapering in each direction from the center towards the ends.



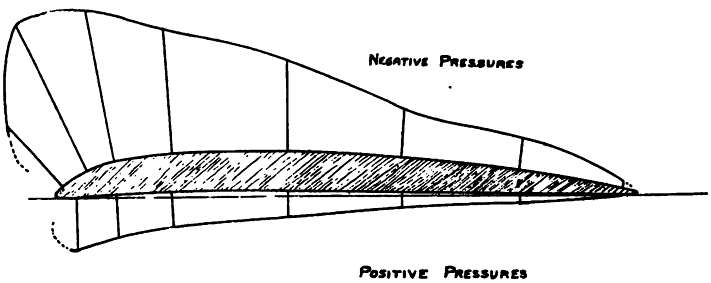


Because, however, of the difficulty of building such struts, it was decided that the one which would be most satisfactory was a spruce strut of a square cross section, built to taper from the center toward each end. Special pin jointed metal fittings were attached to the ends of these struts, and these fittings attached to fittings through the wing beams at the neutral axes.

In the investigation of the shapes and materials to be used in the construction of the wing struts, it was found that steel struts of circular cross section, suitably streamlined, would be very

light. The main disadvantage of these struts was in the extreme thinness of the metal to be used in their construction, if the weight for a given strength was to be kept below that of the spruce struts. This also was true of aluminum struts. Because of these facts it was decided that the most satisfactory struts would be routed spruce struts for the engine section panels, and, for the other panels, spruce struts built up in a box form with the sides curved to conform to a streamlined section, these built up struts to be covered with a micarta covering of streamline form.

To decrease the weights of the struts, it was decided to tie them together at their middle points, across the entire length of the wing panels, parallel to both the front and the rear beams.

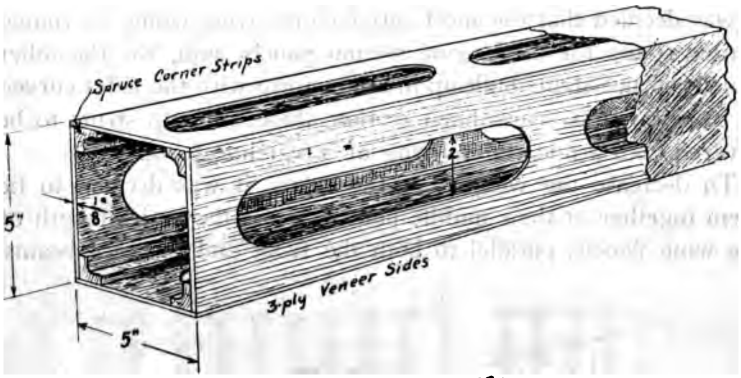


PRESSURE DISTRIBUTION ON RAF-6 AT 6° ANGLE OF INCIDENCE

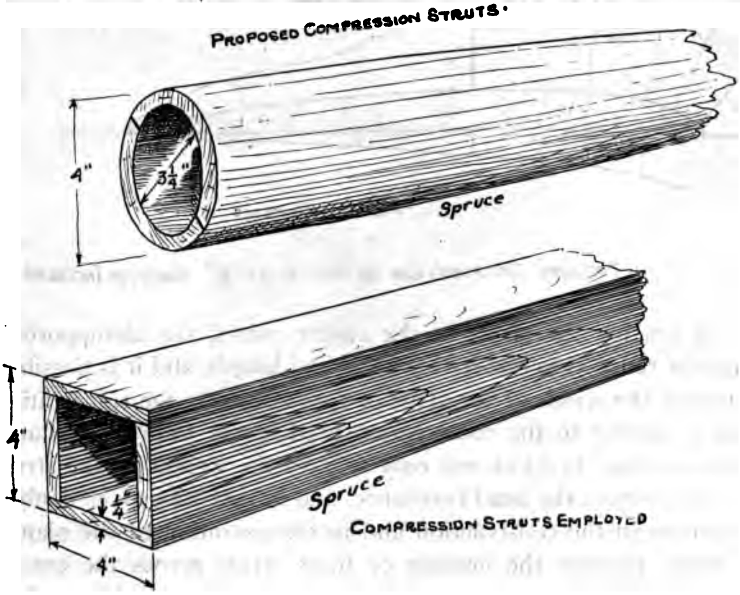
By so bracing the struts at the center points, the unsupported length is reduced to one-half the original length, and it is possible to reduce the width of the strut in approximately the same ratio. This is similar to the construction used in the Caproni biplane. This reduction in width not only reduces the weight of the strut but also reduces the head resistance, and in that way gives double advantage in the construction and in the operation of the plane. To make possible the bracing of these struts across the entire length of the wing panel, it is necessary to reinforce the outside struts to prevent them from bending. This reinforcing is accomplished by means of a kingpost at the center, guyed by bracing wires running to the upper and lower ends of these struts.

Among the parts of the airplane structure requiring the greatest amount of study are the metal fittings used in fastening the

different parts of the structure together, and in forming the terminals for the many wires. In determining the metal to be used for these metal fittings, various steels of high tensile or of



PROPOSED COMPRESSION STRUTS.

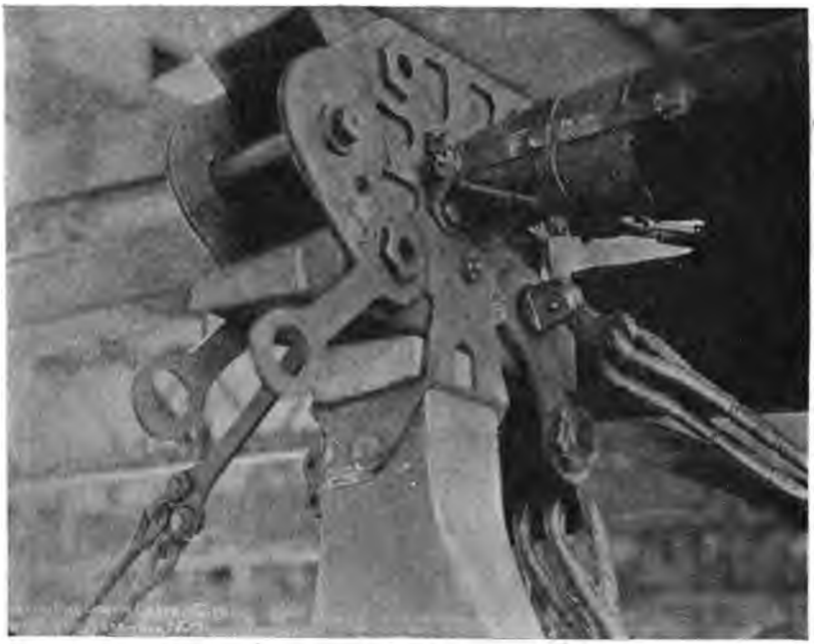


COMPRESSION STRUTS EMPLOYED

low tensile strength were investigated, as well as the aluminum alloys which were offered. For reasons already stated, aluminum fittings would have been unreliable. The most desirable metal for these fittings was decided to be steel, and, after a considerable amount of investigation, which included the manufacture of

parts and the subjection of these parts to various heat treatments, it was decided that a vanadium alloy steel with an ultimate strength of 150,000 lbs. per square inch would be the most satisfactory for this use. To obtain this strength, it was necessary to subject the parts to a special heat treatment.

This heat treatment must be carried out very carefully, and it has been found during the process of manufacture that a great



Outrigger Assembly, "NC-1."

many parts have been spoiled. As a result of the destruction of so many parts during manufacture, and of the doubts felt by some persons of the absolute reliability of heat treated steels, there has been extended discussion of the advisability of using such steels for these fittings. Inasmuch as a saving of approximately 200 lbs. in weight was secured in this way, this use has been justified. It is certain such use of high tensile steels will continue, as in airplane design the engineer must take advantage of all opportunities afforded by the materials with which he works.

During flight the stresses in the various parts of the wing panel structure are transmitted along the wing panels to the hull by means of the flying wires. During combat it is very possible for one or more of these flying wires to be cut by gun fire. To prevent, as far as practicable, the destruction of the machine due to the cutting of any one of these wires, the design called for these stresses to be carried by three wires in parallel instead of a single one. In later designs, when the need for war purposes had passed,

WING HINGE ASSEMBLY, "NC-1."

this was changed, and the load was carried by two wires in parallel instead of by three. By this change considerable weight and much resistance were removed. It was planned in the original design to have the landing wires, which carry the stresses due to the weight of the wing panels when the machine is landing or at rest, made up of two wires in parallel, but when the flying wires were reduced to two, the landing wires were reduced to a single wire. These landing and flying wires are made of a non-flexible steel cable varying in size from $\frac{3}{8}$ inch to $\frac{1}{8}$ inch in diameter. To reduce the resistance of these wires to a minimum, those in the

wing truss construction are streamlined. For the double wires a routed spruce streamlining is used, and for the single wires a special one of rubber.

In the design of the hull, certain requirements must be met. These requirements may be briefly discussed as follows: The hull must have sufficient buoyancy to support the weight of the craft when on the water. The usual requirement in hull construction is that there shall be a reserve buoyancy of 500 per cent. The hull must have enough stability to keep the wing panels, propellers, and tail surfaces well clear of the water, and must provide reserve stability for possible operation in strong wind or in a rough sea. As the position of the plane changes, the position of the center of buoyancy must change quickly enough to provide this stability, and to bring the machine back to normal. The hull must be of such a design as to steer readily, especially at moderate speeds, on the water. The bow of the hull must be so built as to prevent nosing under at high speed in rough water or in a bad landing. It should also be so designed as to prevent the throwing of spray during taxiing or planing. This throwing of spray may be prevented to a large extent by the use of thin strips known as spray strips along the sides of the bow.

The shape of the bottom of the hull is of great importance in the operation of the machine. It has been found that a wide bottom planes very quickly. A flat bottom planes quickly, but is unstable, and is likely to cause fore and aft rocking of the machine during planing, which is known as "porpoising." The V-bottom eases entrance and getaway and prevents porpoising, but is very likely to throw large quantities of spray. A concave V-bottom has the same advantage as the V-bottom but is difficult to handle, especially in making a skidding landing. Considering all points, the V-bottom is the most satisfactory in its actual use.

To facilitate the lifting of the hull from the water, the hull bottom is built with a portion which has a sharp change in direction at a position a short distance aft of the center of gravity. This portion is known as the step. It is well known that water in motion tends to follow closely any curved surface submerged in it, but will throw itself completely away from a surface in which there is an abrupt change of direction. This fact is made use of in the design of the step and in the design of the hull bottom

aft of the step. The portion of the bottom aft of the step is almost flat and slopes upward at an angle of approximately 3° to the deck. During the time of planing, the water from the step is thrown clear of the after portion of the hull, thus preventing much of the suction which might arise if the water followed more closely the lines of the hull. To aid in preventing this suction, breather tubes, extending from the hull deck downward through the bottom at a point just aft of the step are very commonly used. For the *NC* hull, however, it was decided that these breather tubes were not necessary.

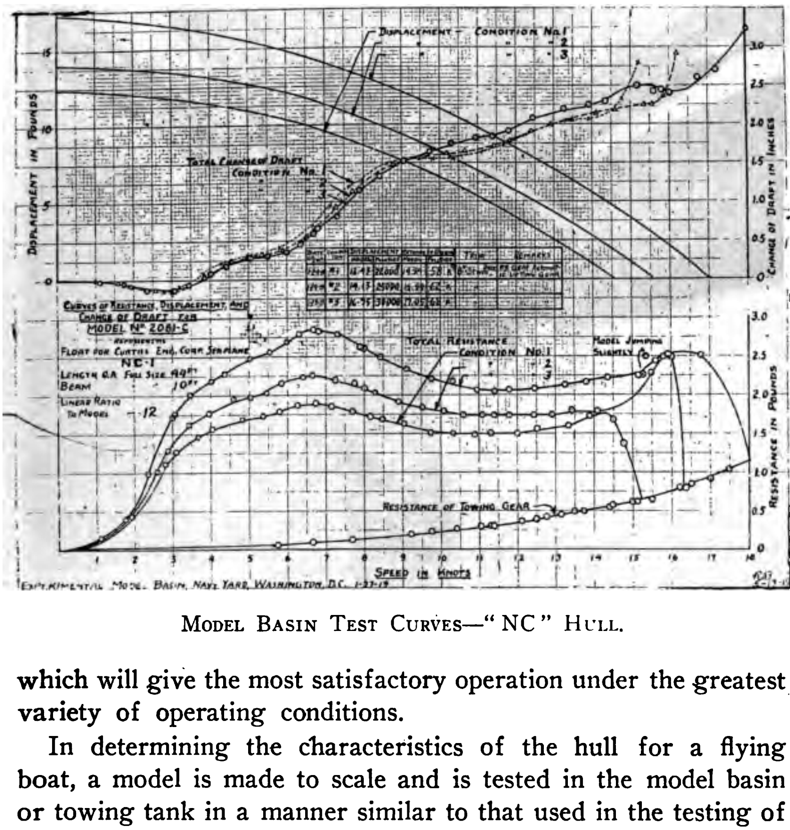
"NC-1" HULL, SIDE VIEW.

The bottom should be so designed that the hull does not plane too rapidly. If, due to too large a planing surface, planing is reached at too low a speed, the machine, when operating on rough water, may be thrown from the water before flying speed has been attained, with a consequent heavy pounding of the hull. The design should be such that the maximum planing speed is always above the minimum air speed. This would provide for the possibility of a getaway with a following wind, which would be the worst possible condition to be considered.

The design of the hull should be such as to offer a minimum resistance to motion through the air during flight. It should

also be so designed as to interfere to as small an extent as is possible with the lift to be produced by the wing panels.

It is very necessary that the hull be rugged enough in its construction to withstand the pounding and rough usage to which it will be subjected during times of getaway and landing. Many of these requirements would call for radically opposite methods of construction, and where such conditions arise, the judgment of the designer must be used to effect a compromise



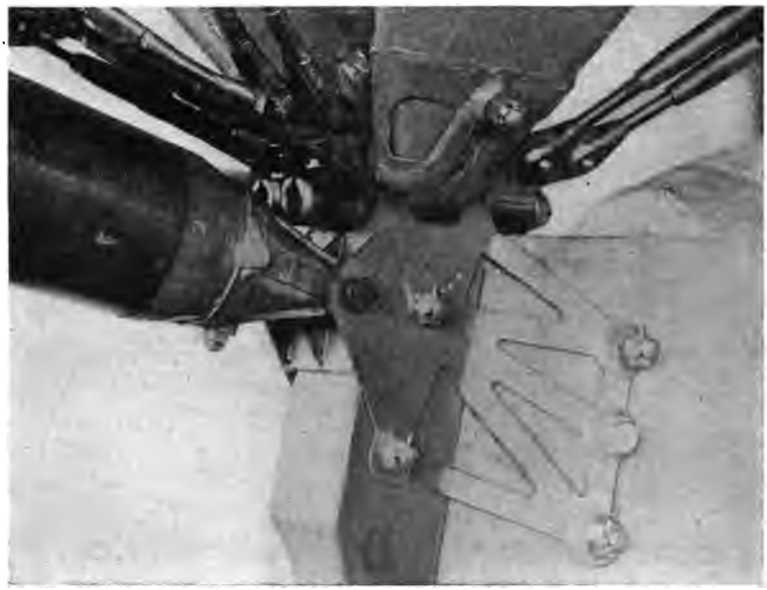
MODEL BASIN TEST CURVES—"NC" HULL.

which will give the most satisfactory operation under the greatest variety of operating conditions.

In determining the characteristics of the hull for a flying boat, a model is made to scale and is tested in the model basin or towing tank in a manner similar to that used in the testing of models of ships. The accompanying curves show the results of the model basin tests of the *NC* hull under three conditions of loading. These curves are self-explanatory.

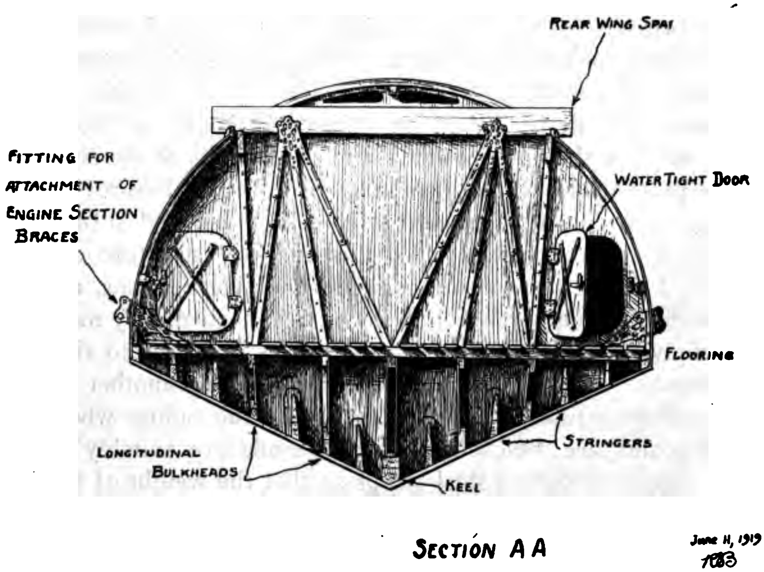
The *NC* type of hull, with the tail surfaces carried on outriggers supported in part from the upper rear wing beam and in part

from the hull stern post, was suggested by Mr. Curtiss in his original proposal. The details of the hull design are largely the work of Commander H. C. Richardson, of the Construction Corps. Commander Richardson had had a very wide experience in the design and testing of pontoons for seaplanes, and, as a result of this experience, was best qualified to take up the design of a new hull of the type to be used for the *NC* flying boat. As the result of his experience in the design and testing of pontoons, he decided

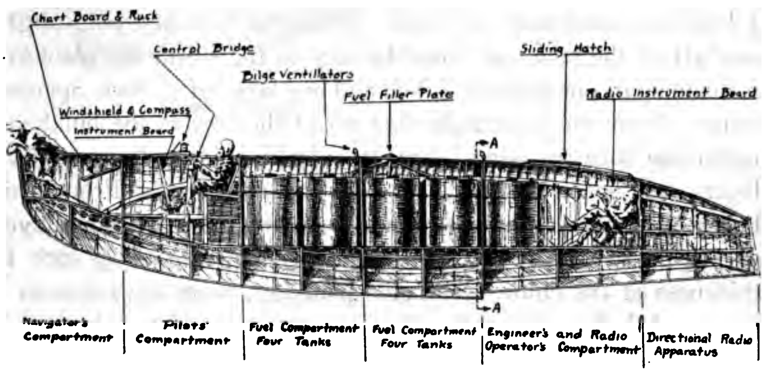


TAIL FITTING AT STERN POST.

that a very satisfactory float could be produced by modifying the design of the *R-6* pontoon which had proved very successful in its use in seaplanes. Accordingly, the general dimensions of the hull were determined by increasing the dimensions of the *R-6* pontoon in the ratio of the cube root of the displacements. The shape of the V-bottom is similar to that of the Curtiss *H-16* flying boat, and to the British *F-5*, which was later adopted by the U. S. Navy. Changes were made in the shape of the deck of the pontoon, at the bow, to allow for a gunner's cockpit, and the stern was changed to allow for the stresses produced due to



CROSS SECTION OF HULL SHOWING WING BEAM SUPPORT AND ATTACHMENT.



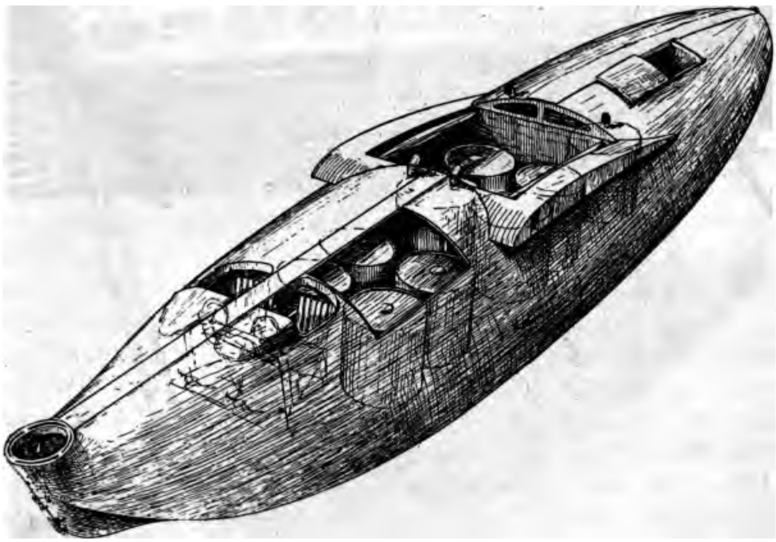
LONGITUDINAL SECTION OF HULL SHOWING TANKS, CONSTRUCTION, BULKHEADS, AND INTERIOR ARRANGMENTS.

the weight of the tail surfaces to be supported from the stern of the hull.

To provide for the heavy weights to be carried in the hull, for which no provision was made in the design of the *R-6* pontoon, the internal construction was very different from that of the pontoon. The design called for sufficient strength for 10,000 lbs. of gasoline in the hull, in addition to the weights of the crew and spare parts which would also be carried there. To provide this necessary strength a fuselage structure of ash and spruce was the basis of construction. To this fuselage structure suitably designed floors, floor stringers, keels and side keelsons, and the framework to support the hull deck, are attached. By means of five 2-ply mahogany bulkheads, the hull is divided into six compartments. Access from one compartment to another is had through watertight bulkhead doors. At the points where the wing beams are attached, these bulkheads are suitably braced with spruce strips and steel straps so that the weight of the hull is distributed throughout the bulkheads and to the wing beams without producing excessive strain on any one part of the structure.

The bottom planking of the hull is Spanish cedar, made up in two layers with a layer of batiste and marine glue between. To provide for the pounding of the hull bottom, and to give the required strength with a minimum weight, the bottom planking is made up in various thicknesses ranging from a minimum of $\frac{1}{8}$ inch to a maximum of $\frac{1}{4}$ inch. From the bow to a point eight feet aft of the bow and from the step to the stern, the planking is made up of one layer of $\frac{1}{8}$ inch and one layer of $\frac{3}{16}$ inch Spanish cedar. From the point eight feet aft of the bow to the bulkhead under the forward wing beam, the planking is made up of two layers of Spanish cedar, $\frac{3}{16}$ inch in thickness. From this bulkhead to the step, there is one layer of $\frac{3}{16}$ inch and one layer of $\frac{1}{4}$ inch Spanish cedar, the outer layer tapering to $\frac{3}{16}$ inch in thickness at the chine. The side planking, from the chine to a point $15\frac{1}{2}$ inches above the chine, is made up of two layers of $\frac{1}{8}$ inch mahogany planking. From this point upward, the deck covering is one layer of $\frac{3}{32}$ inch white cedar, covered by light cotton duck, glued to the planking with water-proof glue. In one of the hulls this planking is of thin 3-ply veneer and the duck covering is not used.

As in the design of the other portions of the machine, weight estimates were made as soon as the design had progressed to the point where this was possible. The estimated weight of the hull was found to be considerably in excess of the weight allowed, and it was therefore necessary to make a reduction in this weight. Commander Richardson took this up and, as a result of his experience in design, reduced the sizes of all parts to those he considered as the minimum allowable. Upon a recalculation it was found that the estimated weight came within the figure allowed for hull

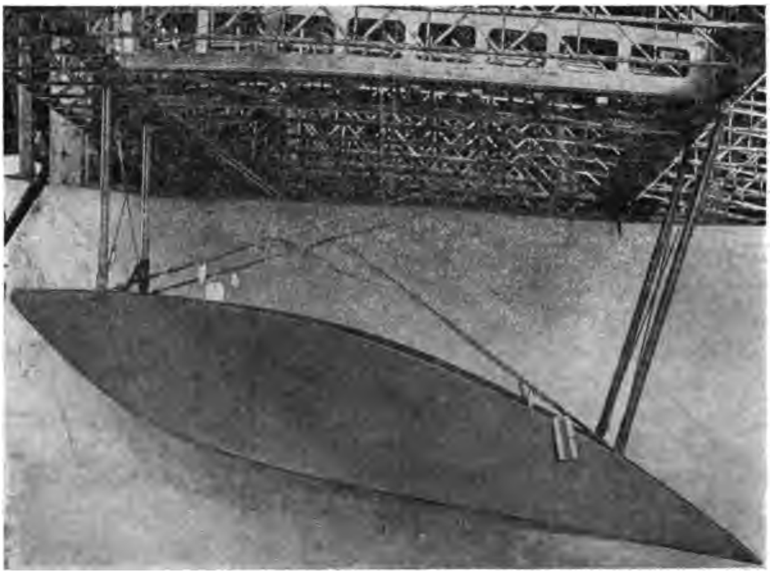


GASOLINE TANKS IN HOLD.

weight. It is interesting to note at this point that the weights of the four hulls as constructed, all exceed the estimated weight of about 2400 lbs. by amounts varying from 100 lbs. to 300 lbs.

To prevent the wing panels coming in contact with the water during taxiing, or when the machine is moored in the water, it is necessary to provide wing tip pontoons. Design of such pontoons is similar in many respects to the design of the hull. They must be especially rugged in their construction because of the great possibility of their being damaged during a bad landing or during landing in a rough sea. They must have a considerable displacement to prevent the wing tips being submerged when

the machine is rolling badly on a rough sea. With the original wing tip pontoon, when the pontoon is completely submerged and the wing tip is about to touch the water, the righting moment is 2.65 times the tipping moment due to the weight of 22,000 lbs. With a load of 29,000 lbs., the righting moment would be double the tipping moment. The size of the pontoon was later increased and the shape changed to overcome the tendency to nose under during taxiing on rough water, with the consequent subjecting



WING TIP PONTOON, ORIGINAL DESIGN.

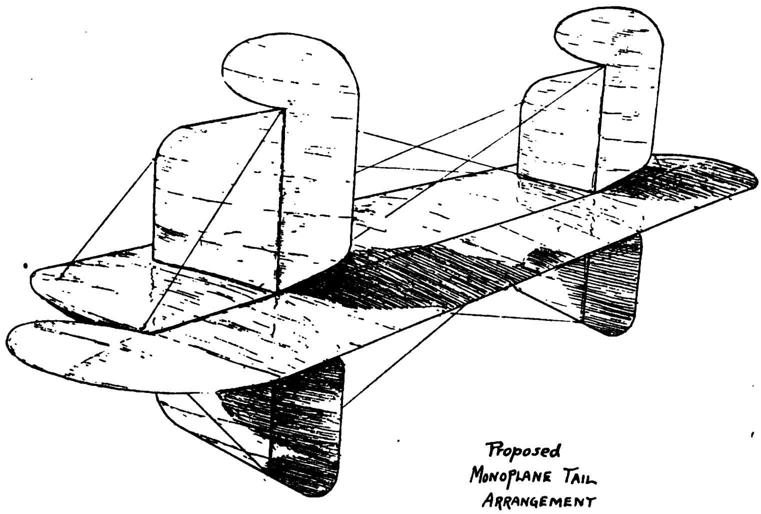
of the wing beams and pontoon struts to very sudden and severe strains.

There are two methods that may be used in determining the areas to be used in the construction of the tail surfaces. One of these is an analytical method which makes use of an equation derived from the consideration of many machines which have been in satisfactory practical use. This equation may be written $a = .51\ AC/L$, where a represents the combined area of the horizontal stabilizer and elevators, A represents the total wing area, C represents the wing chord and L represents the distance between

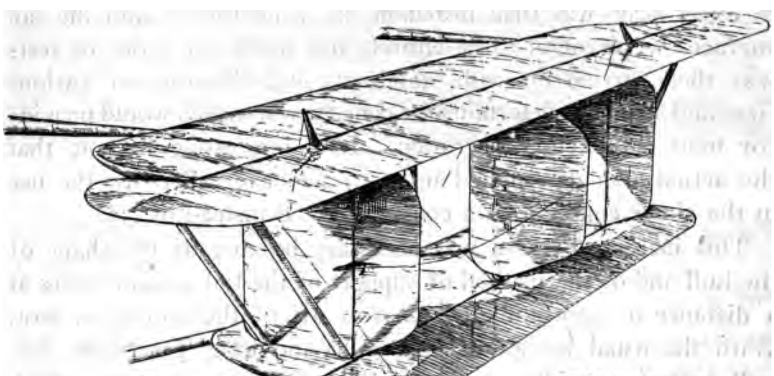
the mean centers of pressure of the wing panels and the tail surfaces. The use of this equation will give an approximate value of the necessary horizontal control areas, which is then apportioned to stabilizer and elevator in the ratio of 1.2 to 1. It is wise, however, to construct a model of the complete machine and to determine the effectiveness of the tail surfaces by a test of the model in the wind tunnel, which constitutes the second method of determination as noted above. This method is the one which should be used as a check in all cases, as it shows very definitely the operating characteristics of the machine. If these characteristics are not quite satisfactory, changes in the size and shape of these control surfaces may be made and tests may be repeated until a satisfactory arrangement is obtained. It is customary in design to make the span of the horizontal stabilizer approximately one quarter of the total wing span and to make the distance between the mean centers of pressure, as noted above, equal to approximately three times the wing chord. With these relations as a basis of the design, it is possible to determine the approximate areas for the control surfaces, and then by means of a wind tunnel test to determine the exact area required.

The analytical method described above was applied to the design of the stabilizer and elevator for the *NC* boat. A model made to exact scale was then tested in the wind tunnel, and the tail surfaces were found to be entirely too small. A series of tests was then carried on with stabilizers and elevators of various sizes and shapes to determine the construction which would provide for most satisfactory operation. It is interesting to note that the actual area determined upon would have called for the use in the above equation of a constant of .68 instead of .51.

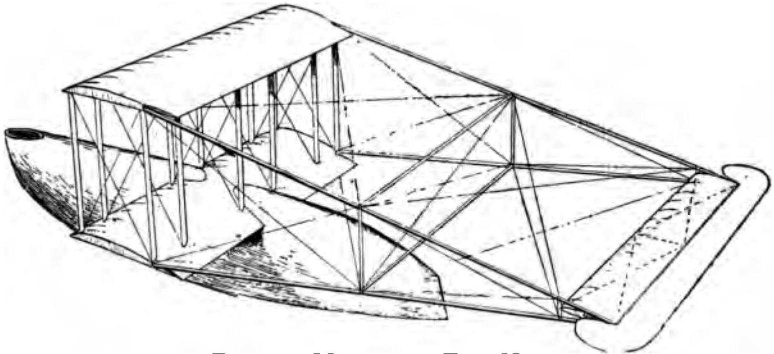
This increase of area was necessary because of the shape of the hull and of the method of support of the tail on outriggers at a distance of approximately 20 feet aft of the hull stern post. With the usual design of boat hulls the long, practically flat, hull bottom provides a considerable stabilizing surface, which is entirely absent in this construction. To make up for this decrease in hull surface, additional area must be provided in the horizontal stabilizer. This is true also of the vertical stabilizers, which were of a larger proportional area than is used on the conventional type of flying boat.



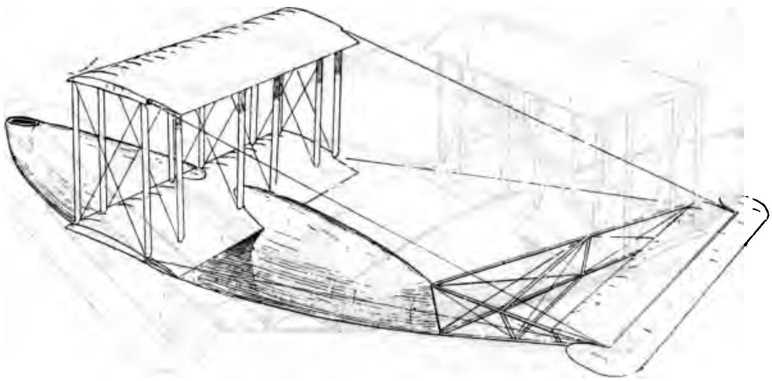
Proposed
MONOPLANE TAIL
ARRANGEMENT



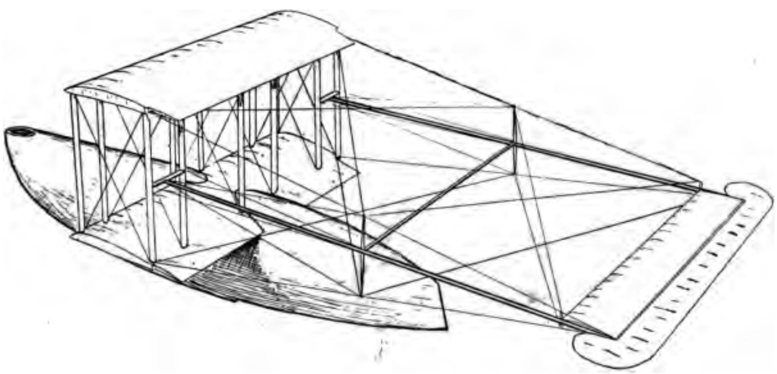
PROPOSED
BIPLANE TAIL
ARRANGEMENT



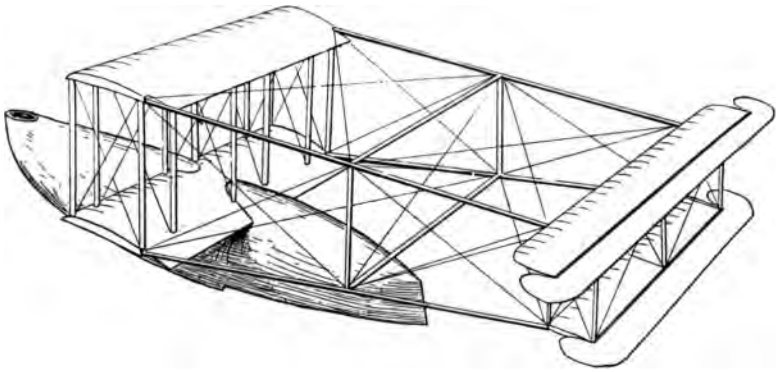
PROPOSED MONOPLANE TAIL NO. 1.



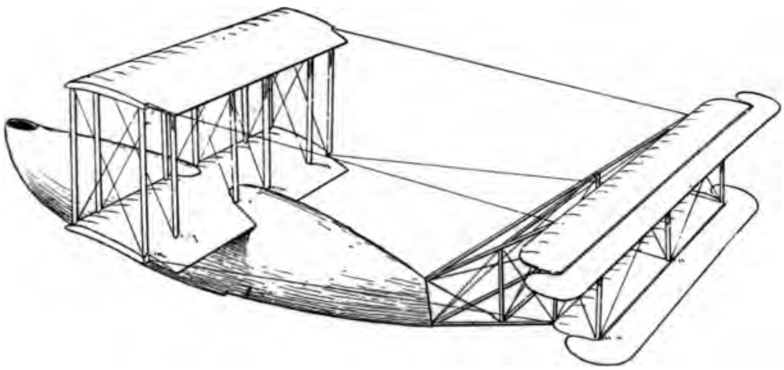
PROPOSED MONOPLANE TAIL NO. 2.



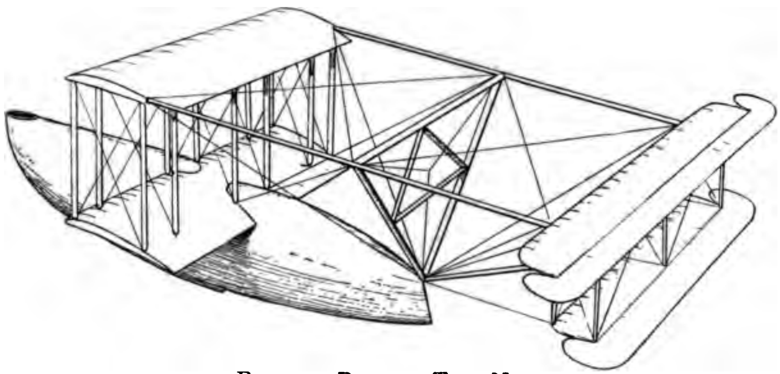
PROPOSED MONOPLANE TAIL NO. 3.



PROPOSED BIPLANE TAIL NO. 1.

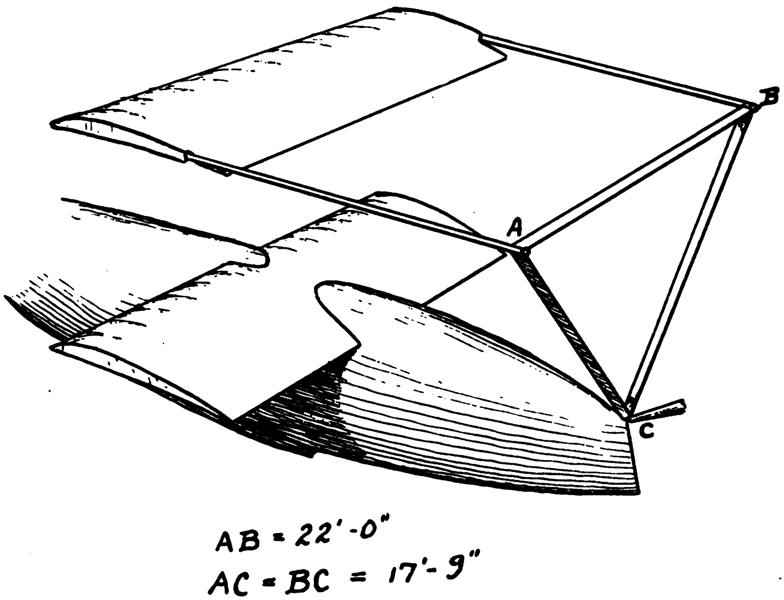


PROPOSED BIPLANE TAIL NO. 2.



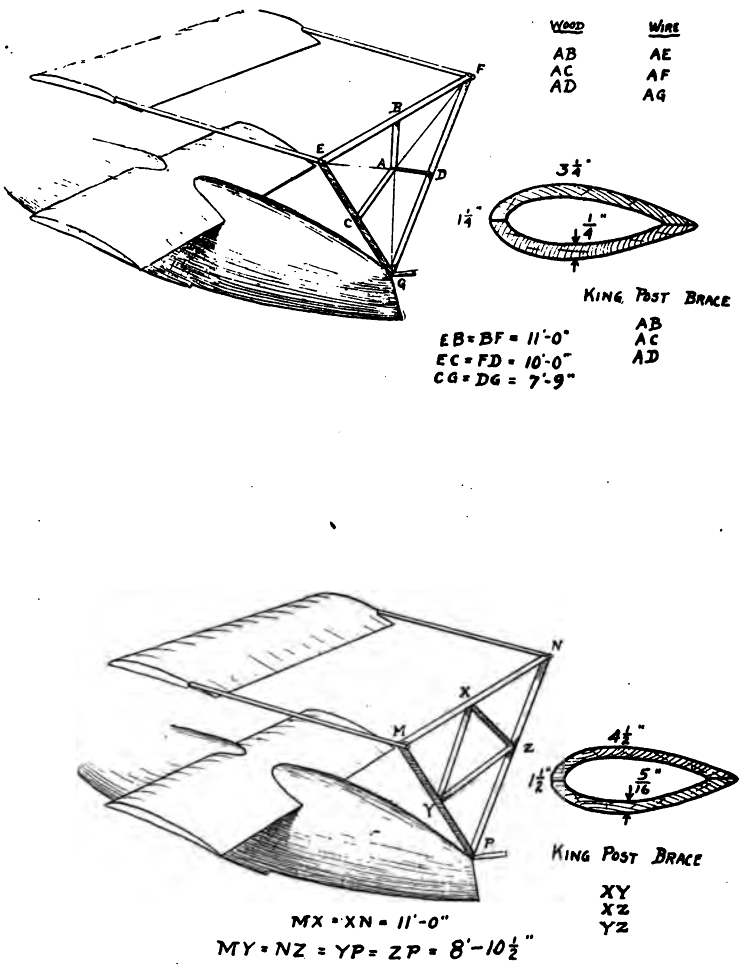
PROPOSED BIPLANE TAIL NO. 3.

In determining upon the type of tail surfaces to be used for this design, four important factors were considered. These were, first, the weight of the total structure; second, the stresses set up in structural members other than those used directly in the support of the tail; third, the rigidity of the complete structure; and fourth, the possibilities of destroying any single member without the destroying of the entire structure.

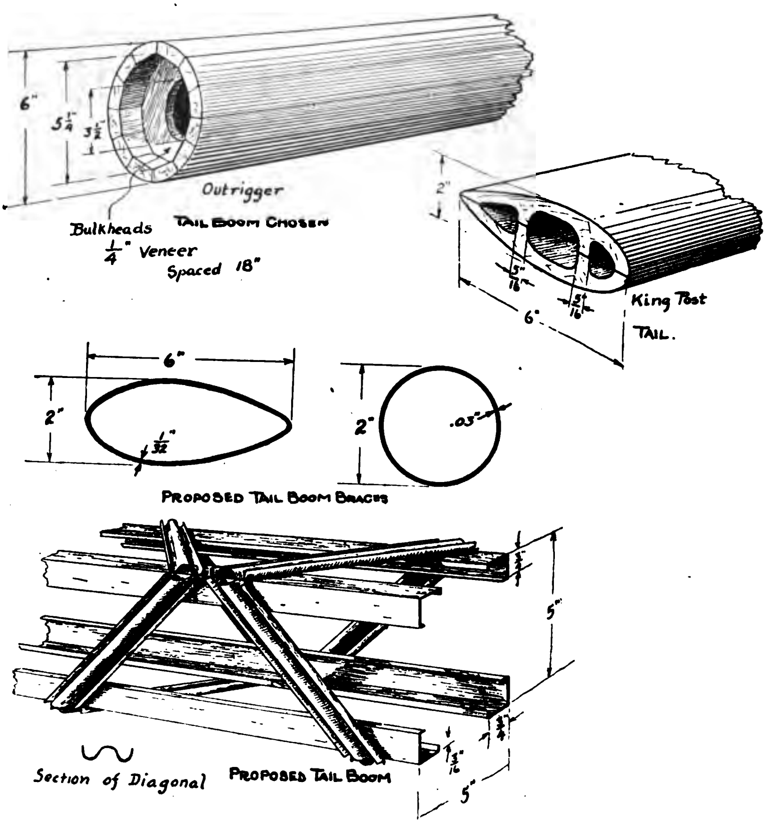


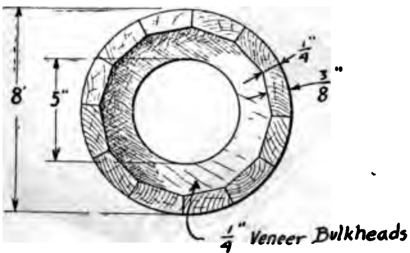
BRACING OF TAIL BOOMS.

In determining the type of tail surface to be used for the *NC* boats, various arrangements of both monoplane and biplane tails were considered. These two types of tails and the various means of supporting them are shown in the accompanying sketches. Without attempting to go into a detailed discussion of the various types considered, it seems sufficient to state that the type chosen as the most satisfactory was the biplane tail No. 3. The main reasons for the choice of this tail were that it was the most rigid in construction, that it actually reduced the stresses in the wing

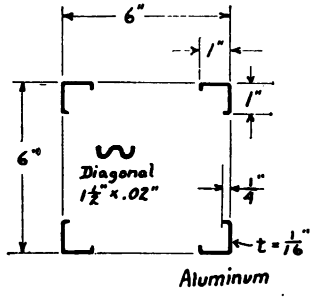


KING POSTING OR BRACING OF TAIL BOOMS

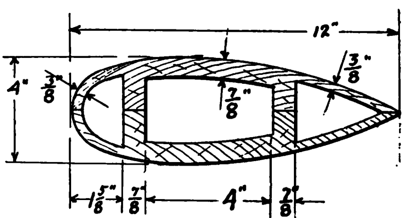

6"
5 1/4"
3 1/2"
Outrigger
Bulkheads
1/4" Veneer
Spaced 18"
TAIL BOOM CHOSEN
2"
5/16"
5/16"
6"
King Post
TAIL.
6"
2"
1/32"
2"
.03"
PROPOSED TAIL BOOM BRACES
3/4"
5"
3/4"
3/16"
5"
Section of Diagonal
PROPOSED TAIL BOOM



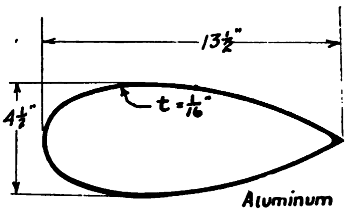
PROPOSED TAIL BOOM



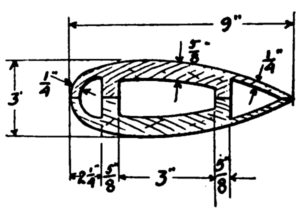
PROPOSED TAIL BOOMS

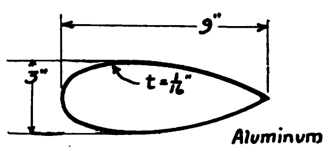


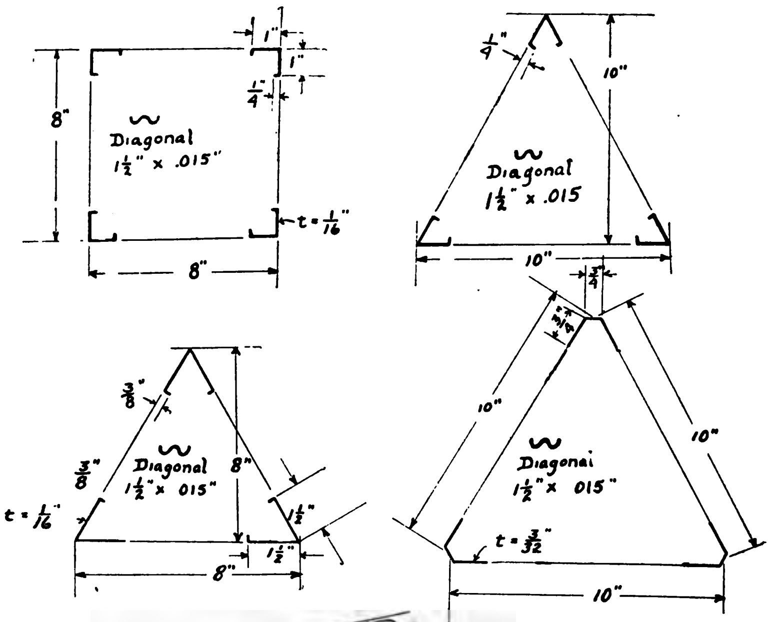
TAIL BOOM BRACES USED.

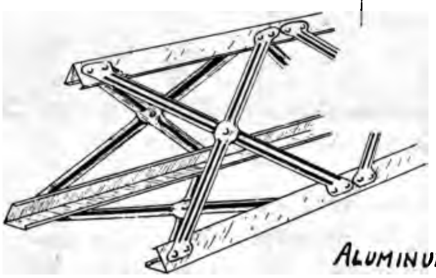


TAIL BOOM BRACES PROPOSED







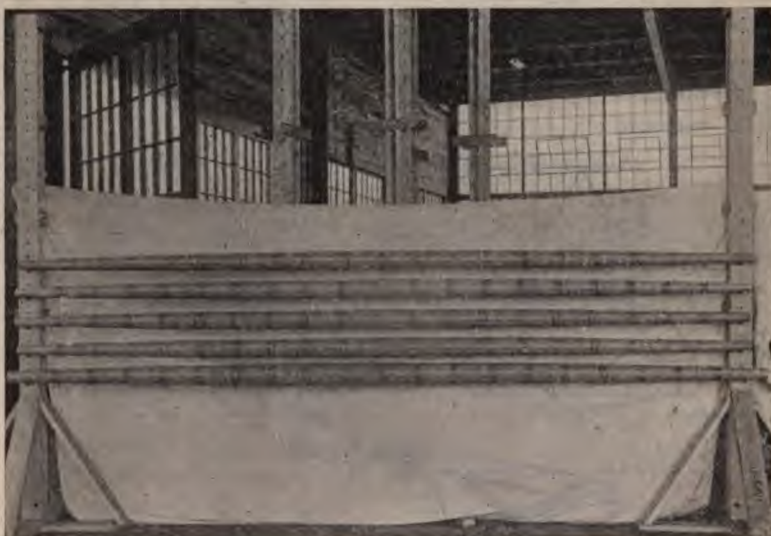


PROPOSED TAIL BOOM.

ALUMINUM
OUTRIGGER SECTIONS

beams instead of increasing these stresses, and that there was less possibility of failure of the entire structure due to a failure of any one of the supporting wires or cables. The actual weight of the structure is somewhat greater than the estimated weights of some of the other arrangements, but this factor is thought to be less important than the other three mentioned above.

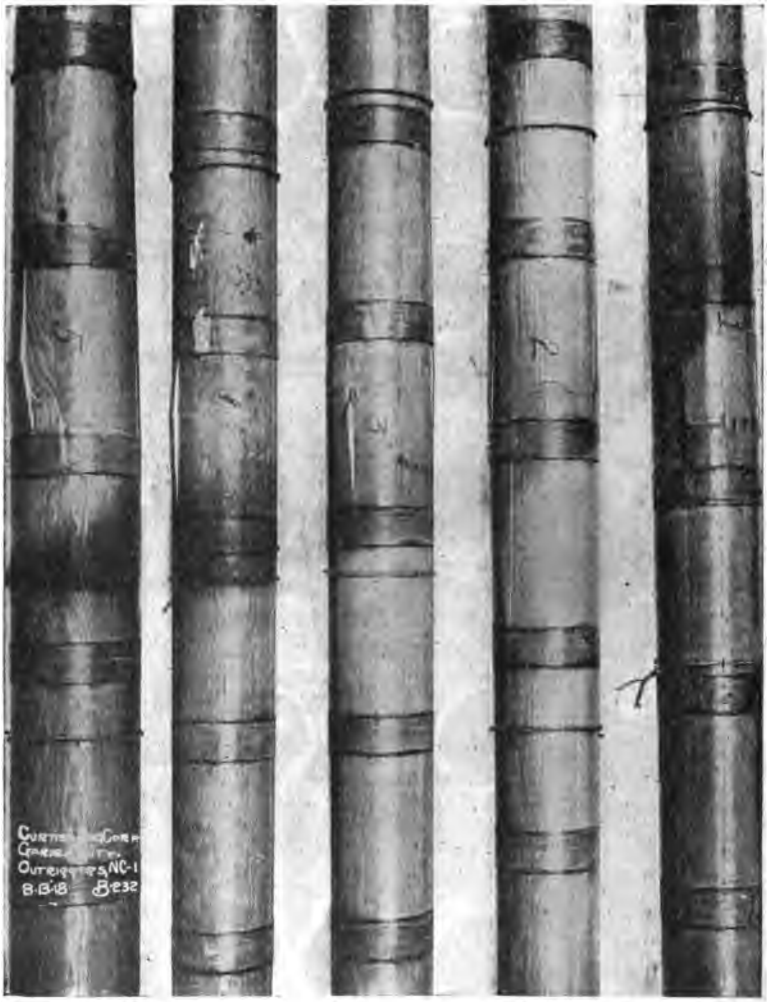
In the investigation of methods of support of the tail, outriggers built of aluminum, steel, and spruce were compared.



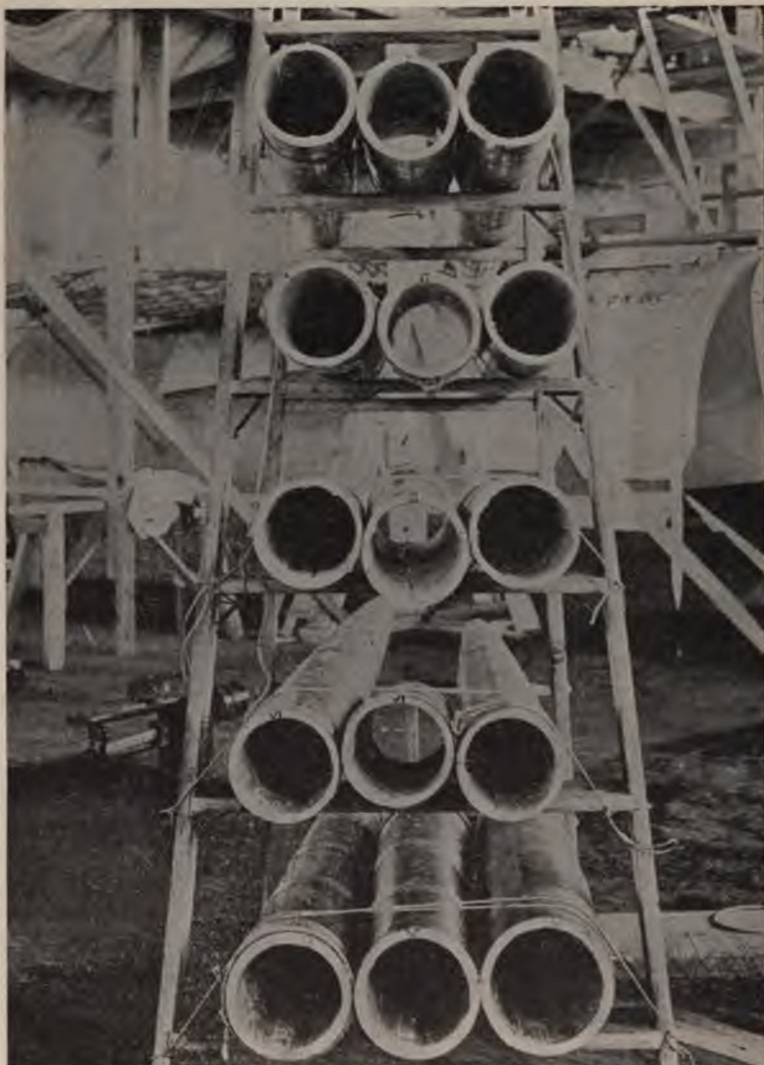
TAIL OUTRIGGERS, AFTER COMPRESSION TESTS.

The various sections considered are shown in the accompanying sketches. Here again, for practically the same reasons as have been outlined above in connection with the discussion of wing struts and wing beams, the spruce seemed to promise the most satisfactory conditions for construction and for use, and, therefore, this material was chosen.

Before this design was entirely detailed, a model of the complete plane was tested at the Washington Navy Yard wind tunnel. A similar model was made later and tested in the wind tunnel of the Curtiss Engineering Corporation. The curves



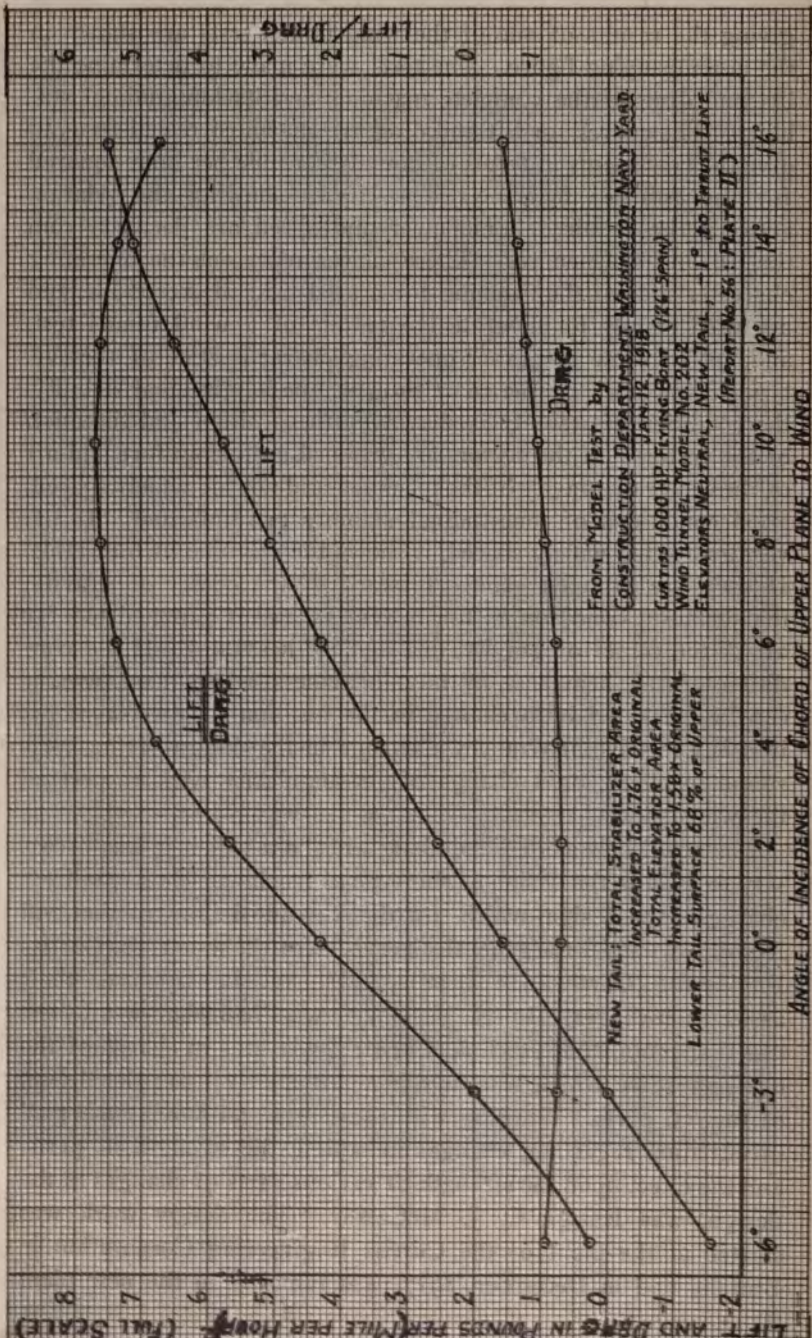
SECTIONS OF TAIL OUTRIGGERS, SHOWING POINTS OF FAILURE DUE TO COMPRESSION TESTS.

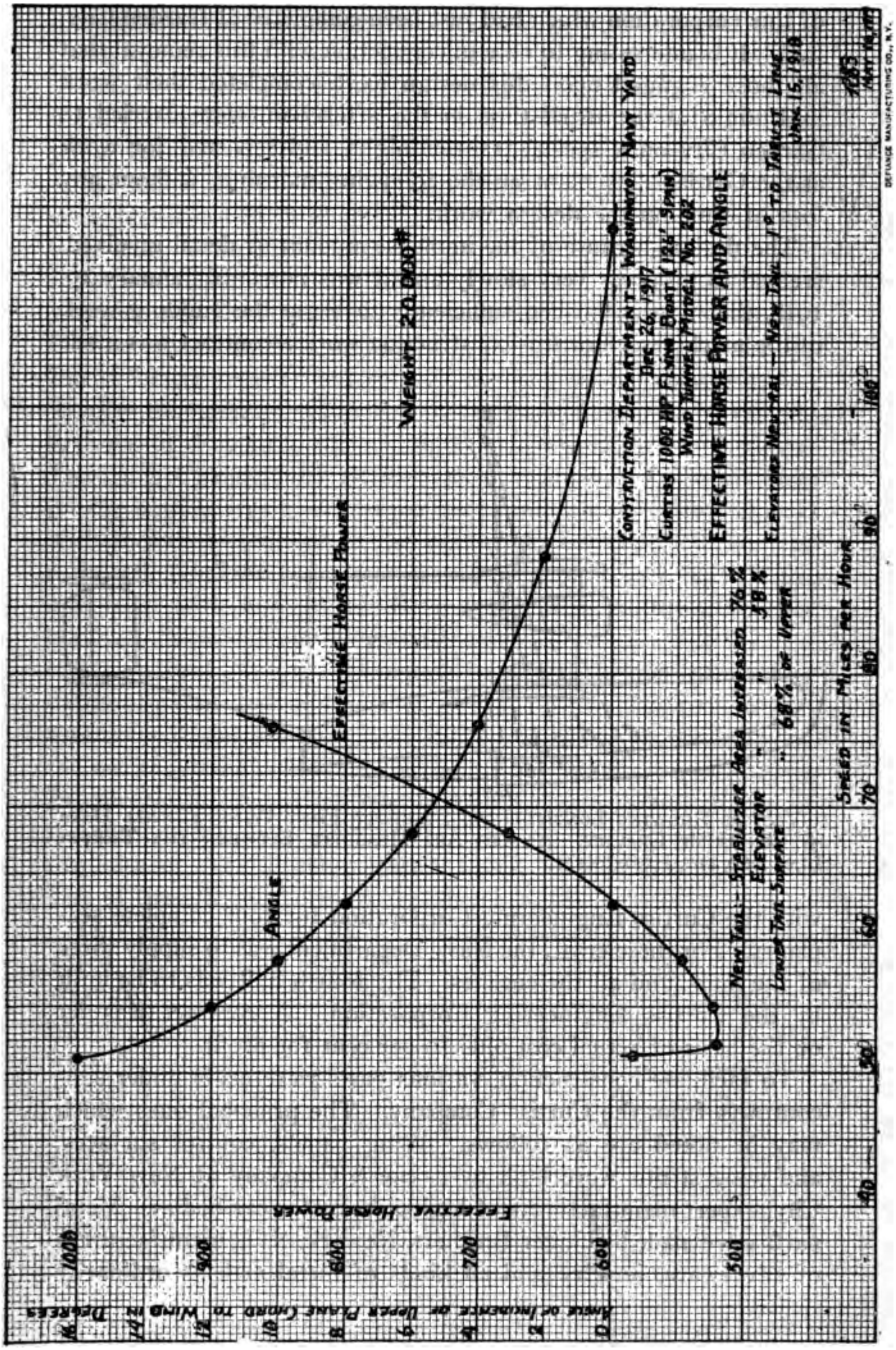


CUT SECTIONS OF TAIL OUTRIGGERS, AFTER COMPRESSION TESTS.

giving the results of one of the wind tunnel tests are shown in the accompanying figure. The tests were made to determine the lift and drag of the complete machine, and its longitudinal stability. The curves for lift and drag are shown corrected so as to give the coefficients in terms of pounds per mile per hour squared for the full-size machine. The curves showing the relation between the required horsepower and speed are derived from the lift and drag curves. These curves represent the operating characteristics of the machine for a total load of 20,000 lbs. and are used simply to illustrate the results of a wind tunnel test, and not to show the exact operating characteristics of the *NC* type of seaplane. In the chart showing the longitudinal stability, the condition of stability is shown by the position and direction of the vectors. If the vectors are grouped uniformly fore and aft of the center of gravity of the machine, and not too widely spaced, good conditions of longitudinal stability are indicated. If the vectors are too widely spaced, it shows the machine as too stable. If they are grouped mainly forward of the center of gravity, it indicates a condition of tail heaviness, and if grouped too far aft of the center of gravity, one of nose heaviness. If the condition of tail heaviness or nose heaviness is not excessive, it can be corrected by a change in the position of the elevators; if it is excessive, it requires a change in the design of the horizontal stabilizer or a change of its angularity with respect to the wing panels.

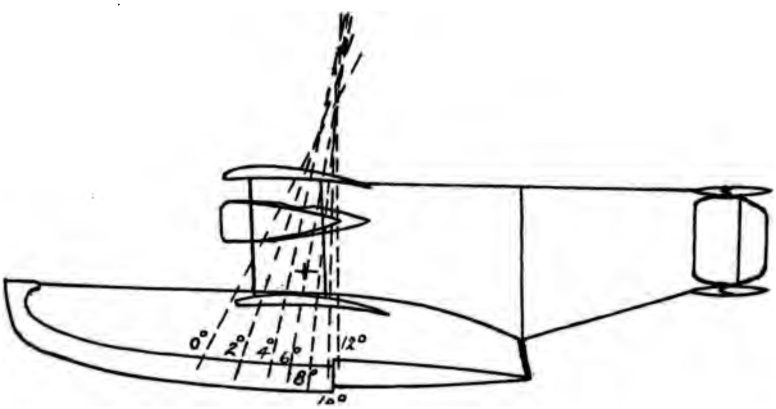
The conditions as outlined above are those which it was necessary to meet in the design of this type of machine. To have direct charge of the design, which, for the Bureau of Construction and Repair, was under the general supervision of the writer, the Curtiss Enginering Corporation detailed Mr. W. L. Gilmore, their assistant manager, Mr. S. V. Davis, who had charge of their drafting room, and Mr. J. A. Christen, who was in charge of the drafting force which was working particularly upon the design of the *NC* parts. Working with these men and looking after all information regarding changes in design, the strength of parts, and the effect upon the strength of various parts of changes in the design, was Ensign C. J. McCarthy. The design work was started at the plant of the Curtiss Engineering Corporation in Buffalo, and in December, 1917, was removed to the new plant


LIFT / DRAG
LIFT
DRAG
FROM MODEL TEST by
CONSTRUCTION DEPARTMENT WASHINGTON NAVY YARD
JAN 12, 1918
CURTISS 1000 HP FLYING BOAT (1/24 SPAN)
WIND TUNNEL MODEL No. 202
ELEVATORS NEUTRAL, NEW TAIL, -1° TO THRUST LINE
(REPORT No. 56: PLATE II)
NEW TAIL: TOTAL STABILIZER AREA
INCREASED TO 1.76 × ORIGINAL
TOTAL ELEVATOR AREA
INCREASED TO 1.58 × ORIGINAL
LOWER TAIL SURFACE 68% OF UPPER
ANGLE OF INCIDENCE OF CHORD OF UPPER PLANE TO WIND
LIFT AND DRAG IN POUNDS PER MILE PER HOUR (FULL SCALE)


ANGLE
EFFECTIVE HORSE POWER
WEIGHT 20,000#
CONSTRUCTION DEPARTMENT – WASHINGTON NAVY YARD
DEC. 26, 1917
EFFECTIVE HORSE POWER AND ANGLE
SPEED IN MILES PER HOUR

of this corporation which had just been completed at Garden City, L. I. It is interesting to note in connection with this removal that all those engaged upon this design work completed their work in Buffalo at the usual time in the afternoon, were carried to Garden City on a special train at night, and reported for work at the Garden City plant on the following morning, without any loss of time on the design work.

The design, because of the immense amount of detail involved, seemed to progress very slowly and it was not until January 19, 1918, that it was finished sufficiently to begin the building work of the machines. For this construction work a contract was made



VECTORS SHOWING LONGITUDINAL STABILITY FROM WIND TUNNEL DATA + CENTER OF GRAVITY. ANGLES ARE MEASURED BETWEEN THE THRUST LINE AND THE HORIZONTAL.

with the Curtiss Engineering Corporation for four complete seaplanes. For these craft, the Navy Department was to supply three of the hulls, and all the engines. The fourth hull was to be built by the Curtiss Engineering Corporation. A contract was let on the basis of actual cost plus 10 per cent for profit.

To facilitate construction, various parts were made under subcontracts from the Curtiss Company. The principal ones which may be noted are as follows. Wing panels, control surfaces, and wing struts, were built by Locke & Company of New York City, expert manufacturers of high-class motor car bodies. Metal parts were made by Unger Brothers, Newark, N. J., manufacturers of silverware, jewelry and all kinds of metal articles ordinarily

handled by jewelers. Later, to expedite the production of metal parts, some of these were manufactured by the Beaver Machine Works of Newark, and some by Brewster and Company of New York City. Wing tip floats were built by the Albany Boat Company, builders of high-class steam launches and motor boats. These, later were replaced by larger floats built by the Naval Aircraft factory of Philadelphia. The outriggers supporting the tail were built by the Pigeon-Fraser Hollow Spar Company of Boston, makers of masts and spars for racing yachts. The gasoline tanks were built by the Aluminum Company of America of Pittsburgh. The construction of these tanks was the largest and most difficult job of this nature ever undertaken by any aluminum manufacturer. Two of the hulls to be supplied by the navy were built by Lawley & Sons of Neponsit, Mass., and one by the Herreshoff Manufacturing Company of Bristol, R. I. These hulls were built on the basis of cost, plus 10 per cent profit on an estimated cost, with the understanding, if the cost could be reduced below the estimated cost, the contractor would be paid 10 per cent on the estimated cost, and, in addition, 25 per cent of the difference between the actual and the estimated costs.

To assist the Curtiss Company in expediting the production of these parts, and to aid in every way in the construction and assembly of the machine, four officers attached to the office of the writer, were detailed to work with Mr. Gilmore of the Curtiss Engineering Corporation, who had been placed in full charge of the construction work on these four machines. Only because of the faithful work of these officers was it possible to complete the first of these flying boats in September, 1918.

This boat, known as the *NC-1*, had a power plant which consisted of three low compression direct drive liberty engines, arranged to drive tractor propellers. This arrangement was chosen because of the necessity of keeping the weights of the motors forward to bring the center of gravity in the required position with respect to the center of lift. After actual tests of the machine it was found that slight variations in the position of the center of gravity had practically no effect upon its operating characteristics, and it was decided to change the arrangement on the third and fourth boats to two tractor motors and one pusher motor. This installation was later decided on for the second boat as well.

The *NC-1* was completed and assembled for tests at the Rockaway Beach Naval Air Station in September, 1918. The engines were tried out for the first time on October 1, and the boat was weighed, to determine the total bare weight, on October 2. In weighing this machine, four platform scales of 8000 lbs. capacity each were used. These scales were so placed that jacks resting upon the scale platforms could be placed directly under the engine section wing beams, at the outer strut stations. By jacking up, the entire weight of the machine was transferred to these four points. The summation of the four scale readings

"NC-1" ORIGINAL 3-MOTOR INSTALLATION.

gave the weight of the plane. By carefully adjusting the position of the machine, leveling it fore and aft and transversely, the weights as indicated on the scales made possible the calculation of the fore and aft position of the center of gravity. The total weight was 12,740 lbs. This weight did not include any supplies or equipment. It was the net bare weight of the machine itself. The estimated weight for the complete machine as worked out by the Curtiss Engineering Corporation was 11,900 lbs., 840 lbs. or 6.6 per cent less than the actual weight. The center of gravity was 65 inches aft of the leading edge of the lower engine section wing panel, or 28 inches aft of the mean center of lift of the wing panels. This condition indicated very decided tail heaviness, and, in the first

trial flight which was made, it was decided to place in the bow of the machine, 15 feet forward of the leading edge of the lower engine section wing panel, a sand load of 1755 lbs., so that with the weights of cooling water, pilots, mechanicians, fuel and oil, the center of gravity would coincide with the center of lift. This would bring the gross weight of the machine in flying condition up to 16,500 lbs.

The first test of the *NC-1* was made on October 4, 1918. In this test, though the craft was very tail heavy, its operation as a whole was very satisfactory, and indicated that the work of the

"NC-1" TAXIING.

designers had been a success. It was found necessary, subsequently, to make slight changes in the position of the horizontal stabilizer to neutralize this tail heavy condition, but, otherwise, no radical changes were necessary in the design or construction.

It might be interesting at this point to note briefly some of the opinions of this craft gathered during the time of its construction. After the hull of the first machine had been completed and preliminary assembly had been partly carried out, Colonel Porte of the Royal Air Force, who had been associated with Mr. Glenn Curtiss in the design of the *America*, the boat which was built in 1914 for Mr. Rodman Wanamaker, for a trans-Atlantic flight, visited the Curtiss Engineering Plant and looked

over the *NC-1*. At that time, Colonel Porte would make no comment beyond the simple statement, "it is very interesting," but from statements made by others who had come in contact with Colonel Porte shortly after this visit, it is evident that his opinion of the boat, if it had been stated, would have been far from encouraging. In July, 1918, a British Aviation Commission headed by Major General Brancker and including as a principal technical officer, Colonel Sempill, of the Royal Air Force, also inspected the boat. Colonel Sempill, in a report upon his return to England, commented as follows: "The hull of this machine was examined and is the design of a naval constructor. The

"NC-1" PLANING.

machine is impossible and is not likely to be of any use whatever." Several people of considerable airplane design experience stated frankly their doubts of the ability of the hull to get the craft into the air, and even Mr. Curtiss himself thought the planing surface of the boat hull insufficient. These are only samples of the opinions which were held by many persons of the design of this machine. The gratification of those connected with the design due to the successful operation of the completed plane can be imagined.

The tests made on the *NC-1* showed operating characteristics very much better, as regards lifting capacity, and speed in the air, than had been indicated by the wind tunnel tests. With the three low compression tractor engines, it got away with a load of 22,000

lbs. at a speed of 52 miles per hour, after planing approximately one minute. The wind tunnel experiments had indicated a getaway speed of approximately 60 miles per hour and a maximum speed of approximately 72 miles per hour with this load. The actual test showed a maximum speed in still air of approximately 80 miles per hour. Because of this exceptionally good showing, it was decided to install high compression engines to determine what load could be handled in this way. Tests made with high compression engines showed the maximum lifting capacity to be 24,780 lbs., as compared with the original 22,000 lbs. for which the craft

"NC-1" ON TRIAL FLIGHT.

was designed. The getaway with this load was made under very unfavorable conditions as to wind and tide, and it is very probable that with more favorable conditions, the three high compression engines would have been able to lift 25,000 lbs.

Because of the possibility which seemed to be indicated, of the machine handling much heavier loads than the 25,000 lbs. just mentioned, it was decided to install an additional engine and make tests to determine the limit of loading of the machine. Accordingly, the *NC-2* was equipped with four high compression Liberty engines, arranged one tractor and one pusher in tandem in a nacelle on each side of the center nacelle. The pilots and controls remained in the center nacelle as in the original design. With

this arrangement of engines, the machine got away successfully with a load of 28,100 lbs.

There are several objections to the double tandem arrangement of engines described in the preceding paragraph. The efficiency of operation of the two engines in tandem can never be equal to the efficiency of operation if the two engines were set up in separate nacelles; in case of failure of one of the tractor engines, the pusher engine becomes exceedingly inefficient because of the propeller of this engine having been designed to operate

DOCKING THE "NC-2."

in the slip stream of the tractor engine; and there is an excessive torque on the rudder which would result from an attempt to keep the plane to its course if one or both of the engines in one of the tandem nacelles should fail in operation.

To obviate as far as possible the difficulties just outlined, it was decided to install in the *NC-3* and *NC-4*, four engines arranged with one tractor and one pusher in tandem in the center nacelle, and one tractor engine in a nacelle on each side of the center. This arrangement would provide for a better efficiency of operation and for fewer difficulties in operation due to a breakdown of any one of the engines. Trials made on the *NC-3*

and *NC-4* proved this arrangement very satisfactory and it was adopted for the installation to be used on the trans-Atlantic flight.

The original design of the *NC-1* provided for a total gasoline capacity of 891 gallons. For this gasoline supply, four 200-gallon aluminum tanks were placed in the hull, and a 91-gallon gravity tank was placed in the upper engine section wing panel, directly above the center nacelle. This capacity was later increased by the addition of two 200-gallon gasoline tanks in the hull compartment forward of the main tank department. When the power plant was changed to four motors instead of three a further increase in

"NC-4" BEACHED BETWEEN FLIGHTS.

gasoline supply was provided for by the addition of two more 200-gallon tanks in the compartment forward of the main tank compartment and one 200-gallon tank in the compartment aft of the main tank compartment. These tanks are all connected by means of aluminum tubing so gasoline may be drawn from all tanks equally. Valves make possible the shutting off of any tank in case of leakage, or the proper adjustment of the center of gravity of the machine, by regulating the gasoline drawn from any tank.

Gasoline is supplied, by means of air driven plunger pumps placed on the hull deck, from the main tanks to a 91-gallon aluminum gravity tank, carried in the center of the upper engine section wing panel as noted previously. This tank is of the same

A 200-GALLON ALUMINUM GASOLINE TANK.

depth as the panel and is designed to have sufficient strength to carry the flying load corresponding to its area. For emergency use, a hand pump is also installed. An overflow line is provided from the gravity tank to the main tanks, and a glass cup connected in this line gives a visible indication of the operation of the pumps. One pump when operating properly, has sufficient capacity to cause a continuous overflow from the gravity tank. Two pumps are provided, and, with the hand pump, insure at all times an adequate supply to the gravity tank.

LIEUT. COMMANDER A. C. READ (CENTER), COMMANDING OFFICER AND NAVIGATOR; LIEUTENANT E. F. STONE (RIGHT) AND LIEUTENANT (J. G.) W. HINTON (LEFT), PILOTS, OF "NC-4" ON THE TRANSATLANTIC FLIGHT.

The gasoline is distributed from the gravity tank to the motors through aluminum tubing, with hand operated brass cut-off valves of the globe type connected in the lines just below the gravity tank. Aluminum cock-valves were used originally, but these were unsatisfactory, due to sticking of the valve. With the cut-off valves open, the supply of gasoline to the carburetor is regulated by the float, the controls for which are located in the pilots' cockpit. The two outer motors are operated through a differential throttle control, and the center pusher and the center tractor have individual throttle controls.

Lubricating oil for the engines is carried in aluminum oil tanks, supported on extensions of the engine bearers. These tanks have a capacity of 40 gallons for each engine. From results obtained in operation, this capacity is much more than is required for the longest lap of the trans-Atlantic flight, 1300 miles. Indications are that 25 gallons per motor would have been more than adequate for this supply.

Radiators are of the honeycomb type. Plate radiators have been tried in the operation of the craft, but had not proved satis-

VIEW OF PILOT'S SEATS, "NC-4."

factory, due to insufficient strength to withstand stresses set up during operation of the plane. With a stronger construction these radiators could be made satisfactory for operation, but it is questionable whether the reduction in head resistance obtained would compensate for the increased weight.

Controls are of the Deperdussin type, so built that two pilots seated side by side can, in case of need in rough air, work together on the operation of the controls. In the pilots' compartment is an instrument board, electric lighted, carrying an air speed meter, an altimeter, tachometers and spark retards. In the engineers' compartment in the hull is a second instrument board, with radiator, water and oil thermometers and oil pressure gauges attached.

The engineer on watch is held responsible for the satisfactory operation of the engines, and can tell from the readings on the instrument board what changes in conditions are necessary to make the operation satisfactory.

To provide a reserve of cooling water, a 20-gallon auxiliary water tank is carried in the hull. By means of a system of copper piping and a hand pump, water may be supplied to any one of the four radiators. The radiator vent pipes are attached to copper tubes leading back to the auxiliary tank. In this way any vapor or steam formed in the radiators is condensed in the tubes and led back to the supply tank. The only loss of water, therefore, would be due to leakage.

In the engineers' compartment are located, also, the wireless telegraph and wireless telephone instruments. The former is made up of two sets, one for use in the air with 100-feet antennæ trailing downward from the tail support, and with power supplied from an air driven generator, and an auxiliary set for use when on the water, with the antennæ carried on the skid fin masts above the upper wing panels, or for emergency in the air, a short trailing antennæ. The former set has a radius of 300 miles, and the latter one of 75 miles. The latter set was so arranged that it could be used also for the wireless telephone connections. For communication between members of the crew of a boat, an intercommunicating telephone set was provided. Connections of this set were so arranged that the wireless telephone receiving set could be plugged into the intercommunicating set, and all members of the crew could hear reports coming in by wireless telephone.

In the stern compartment there is installed a wireless direction finding compass. This is an adjustable wireless receiving coil, with an indicator attached. As the position of the coil is changed the intensity of the sound in the wireless receiver changes. When this sound is a maximum, the indicator attached to the movable coil gives the bearing of the sending station.

Such is the story of the design and construction of the *NC* flying boats. The performance of these machines in the recent trans-Atlantic flight, both in the air and on the water, shows the excellent results that may be obtained by the application of real engineering principles of design to the solution of problems seemingly as impossible of solution as was this one when first proposed by Admiral Taylor.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

A POST GRADUATE COURSE IN EXPOSITION

By H. C. Washburn, U. S. Naval Academy

Introduction

In 1916, at the request of the Secretary of the Navy, the Society for the Promotion of Engineering Education appointed a committee to inspect the Post Graduate School of the Naval Academy, and to make recommendations concerning its needs, as well as to compare it with other technical schools. Among the recommendations of this committee was the following:

> The work of the Post Graduate School should not be confined to the year which the students spend at Annapolis. The school should be a living force permeating the entire corps of officers of the Navy. All graduates of the Naval Academy, in whatever branch of the service, should be encouraged to correspond with the officers of the Post Graduate School and to resort to them for advice and assistance in any technical problems with which they may have to deal. The Post Graduate Department should send out printed or typewritten information which it considers of service to officers, and should keep in touch with them after graduation. The School must not become an . . . . institution for a few . . . . men. Every officer in the Navy should feel that it is his school whether he has ever been a student there or not. . . . . The School should be liberally supported by Congress, and recognized as a most important and valuable branch of the Navy Department.

Further to accentuate the increasing importance and the enlarged possibilities of the school, two concrete illustrations will suffice: First, the Post Graduate School now has a large and well-equipped building of its own. Since its foundation as the School of Marine Engineering in 1909, and until its studies were temporarily stopped by mobilization in 1917, it had occupied cramped and inadequate quarters in the loft of the Marine Engineering and Naval Construction building, Isherwood Hall. It opened its post-war career, however, in the spacious structure

formerly used as the Marine Barracks, which for some months previous had been thoroughly remodeled and renovated. Secondly, as evidence of the complete recognition of the school's standing and prestige, it is worth while to quote from the address delivered by the Secretary of the Navy at the opening exercises, June 16, 1919. Mr. Daniels then said, in effect, that in the future no naval officer " should reach the rank of captain unless he had had engineering experience, and particularly in this Post Graduate School."

This article on one of the so-called non-technical courses at the Post Graduate School is written, then, partly because it is consonant with the recommendations of the visiting committee in 1916, and partly as the beginning, however modest, of a possible series of articles in the Naval Institute which shall keep the naval service in touch with the school, and, what the committee might well have added, as equally or more important, keep the school in touch with the service, by discussion and correspondence.

One of the less strictly technical courses at the Post Graduate School is chosen as the subject of this article because the scientific courses in the curriculum are being reorganized, and the methods to be followed in the near future, no less than the schedule, have not as yet been definitely decided upon.

Recent Developments in Engineering Education

Before describing, however, a specific course in Exposition adapted to the requirements of the Post Graduate School, it seems necessary to consider the fact that the circumstances to be found at a post graduate school for naval officers differ to a considerable degree from the circumstances to be found at the leading civilian technical colleges. Not only is the naval profession distinct from all others, but the time available for all courses at the Navy's Post Graduate School is much less than the time given to study at institutions of a technical character with which it may to some extent be compared.

For these reasons the problem involved in planning a course in English for the Post Graduate School at Annapolis will be more clearly understood if we outline the background, or the recent developments in engineering education which have aroused the keenest interest of leading engineers, engineering societies,

and the presidents and faculties of engineering schools. A brief review is therefore given of recent discussions tending to improve courses in English for technical institutions.

Although the Society for the Promotion of Engineering Education was founded in 1892, and has held annual meetings since then, there is as yet no general agreement as to the material and methods to be used in English courses. *Engineering Education*, the magazine of the Society, established in 1918, has published in almost every month's issue one or more articles discussing the question, and the Society has appointed a standing committee to investigate the problems involved in English courses. This committee on English is composed of C. W. Park, Chairman, University of Cincinnati; Frank Aydelotte, Massachusetts Institute of Technology; J. R. Nelson, University of Michigan; and S. A. Harbarger, New York City. In its preliminary report (*Engineering Education*, June, 1919) the committee makes the following statement: "From communications received since the re-opening of the colleges, it is evident that the temporary suspension of the usual courses has been in some respects beneficial. Instructors show a disposition to revise their subject matter and methods, and they bring to the revision a variety of experience and a fresh point of view, gained in some form of war service. The new start in all lines of instruction makes the time a propitious one for a re-examination and, where desirable, a reconstruction of the curriculum." It is evident from the foregoing statement that the committee expects substantial improvements in the teaching of English in engineering schools; it is also evident that at the present time they consider the situation to be in general unsatisfactory.

Their report then refers, as might be expected, to the most thorough investigation of engineering education ever undertaken, namely, that of Dr. Charles R. Mann, whose report upon his three years and more of effort devoted solely to this subject was published in 1918 by the Carnegie Foundation for the advancement of Teaching. In order to appreciate the value of Dr. Mann's report, and hence give it its true weight, it should be understood that his exhaustive investigation—to quote the President of the Carnegie Foundation, Dr. Henry S. Pritchett—" arose out of the action of a joint committee on engineering education, representing the principal engineering societies. More than three years

ago (or about 1914) the committee had gathered a considerable amount of material bearing on the subject, and had come to the opinion that the work could be best carried out by the employment of some one trained in applied science, who should devote his entire attention to the study, working under the general direction of the committee and in touch with it. The Carnegie Foundation agreed to appoint such a man and to bear the expense of the study. Professor Charles R. Mann, of the University of Chicago, undertook the work under these conditions." Such is the prestige of the Mann report that it is still being studied by the heads of engineering schools the world over.

Therefore, if we cannot find in this highly respected bulletin of the Carnegie Foundation some definite idea of the status of English courses in engineering schools, we cannot find it anywhere. Accordingly, the more important points dealing with this division of Dr. Mann's report are quoted in the following extracts:

With regard to instruction in English, the engineering schools may be divided into two approximately equal groups, the one composed of those schools that maintain the current standard college course; and the other composed of those that are trying to discover a type of work better suited to engineers. In the standard type, of course, the student studies a textbook of composition and rhetoric, learns the rules of correct punctuation and paragraphing, together with the four forms of discourse, and then writes themes on assigned subjects selected by the instructor to give practice in either description, narration, exposition, or argumentation. In some schools the strict adherence to this plan is mitigated [sic] by allowing a choice from among several assigned subjects. The accompanying study of literature consists of a brief survey of the lives of great writers and the analysis of selected passages from their writings. This well-known type, of course, was developed during the latter half of the past century for the purpose of making English an acceptable substitute for the classics in high schools and colleges.

Doubtless because the professional engineers have been so frank in their demand for better training in English, about half of the engineering schools are experimenting with their methods of teaching this subject. These experiments are so varied in plan and execution that it is not possible to classify them. One of the more radical of these is described in Chapter X.

The description thus referred to is as follows:

Perhaps the most striking experiment with this aim is that now being made by Professor Frank Aydelotte in coöperation with the members of the department of English of the Massachusetts Institute of Technology. At this school English is a required subject for all students throughout

the first two years. The first half of the freshman year is devoted to general composition, with the object of eliminating the more common errors of construction and of leading the student to see that excellence in writing comes not so much from the negative virtue of avoiding errors as from the positive virtue of having something to say.

The work of the second term of the freshman year begins with a class discussion of such questions as: What is the difference between a trade and a profession? What is the meaning of the professional spirit? What should be the position of the engineer in this new era of the manufacture of power—that of hired expert or that of leader and adviser? Is the function of the engineer to direct only the material forces of nature, or also human forces? Such questions readily arouse the interest of engineering students and bring on thoughtful discussion, in which different points of view are expressed by the students and debated with spirit. Essays by engineers are then assigned for reading, and after further discussion each student is asked to write out a statement of his own position on the mooted questions. These themes are criticized in personal conferences in which faults are corrected by asking the writer first what he intended to say; and, second, whether the sentence or phrase in question really says it, rather than by reference to formal rules of grammar and rhetoric. Those who have had experience with this work claim that once the habit of self-criticism from the point of view of the idea is established, the student makes astonishing progress in the ability to express himself clearly and independently; he gathers hints from all sources; and in ways too complex for pedagogical analysis he is more likely to acquire such power over language as he is naturally fitted to possess, than he is by current formal methods. . . . .

Having discussed the question: What is engineering? the class proceeds in the same manner to wrestle with such problems as: What is the aim of engineering education? What is the relation between power of memory and power of thought? Is there any connection between a liberal point of view and capacity for leadership? What qualities do practical engineers value most highly in technical graduates? . . . . What is the relation of science to literature? The authors read in connection with the discussion gradually change from engineers to scientists like Huxley and Tyndall, and then to literary men like Arnold, Newman, Carlyle, and Ruskin. The student seems to read this material with no less keen interest than was shown for the writings of engineers; so that through his own written and oral discussion of masterly essays each comes to work out for himself some rational connection between engineering, with which he began, and literature, with which he ends. No orthodox point of view is prescribed; his own reason is the final authority.

A similar experiment along analogous lines is being made by Professor Karl Young [formerly Professor of English at the Naval Academy] and his colleagues in the department of English at the University of Wisconsin. Reports indicate that this type of course is a great success there also. The materials used in both these courses have been reprinted in book form for the convenience of the classes. [Aydelotte: English and Engineering.

New York: McGraw-Hill, 1917; The Oxford Stamp, Essay X. New York: Oxford Press, 1917; Foerster, Manchester & Young: Essays for College Men. New York: Holt, 1913.]

NON-TECHNICAL COURSES AT THE POST GRADUATE SCHOOL

Before proceeding to explain the bearing of the course in Exposition at the Post Graduate School upon the problems thus discussed in the foregoing review of developments in engineering education, it should be stated that the course in question is to be, if present plans are carried out, one of four non-technical courses, or "half-courses," since perhaps all of them will be scheduled for not more than an hour or two a week, and will extend over not more than four months. In addition to Exposition, there will probably be a course in Methods of Study, one in what may be called the Humanities, not yet definitely planned, and one in Political Economy. The course in Exposition, therefore, should be considered in its relation to three other courses, as well as in terms of a single course.

THE COURSE IN EXPOSITION

It is clear that the methods used during the second term at the Massachusetts Institute of Technology, however excellent for that school, are not altogether adapted to the Navy's Post Graduate School. In the first place, the Technology course is for freshmen—whose average age is perhaps between eighteen and nineteen—while the courses at the Post Graduate School, Naval Academy, are for commissioned officers in the Navy—who have been graduated from the Naval Academy at least five years, and who are on the average about twenty-seven years old. Moreover, the post graduate student officers, if they have had not more than the elementary course in English at the Naval Academy, and have been out of touch with English studies for a least five years, are nevertheless men whose experience and whose positions of responsibility place them in a very different category from the students in the first year, or in any year, at the Massachusetts Institute of Technology.

Also, the element of time available for a given course, when we compare the two institutions, brings out another important difference. One the one hand, we are considering a half term which

is but one-fourth of the whole course of two years; on the other hand, we are obliged to deal with a naval post graduate school whose entire course—at Annapolis—lasts but one year, and in that year the course in Exposition is given three times, to three different groups of officers, so that the duration of the course itself is limited to sixteen weeks, with one hour a week, and possibly not more than fourteen hours, all told. In fact, the course must be planned for fourteen hours, with the possibility of short extensions.

All the factors being duly considered, it becomes necessary to organize a course in Exposition which shall be as practical as it can possibly be made, and which shall be adapted as closely as possible to the circumstances and the needs of the post graduate student officers. With the most recent developments of engineering education as the background, and with the well-nigh unique situation at the Post Graduate School in the immediate foreground, what shall be done? It is hoped that officers in the naval service who are interested in the solution of such a problem will offer their suggestions, and criticize the outline of the course herewith presented. It is hoped, further, that once a solution is found, naval officers who desire to increase their proficiency in writing on professional subjects will have a course at hand which they can feel confident will be sound in theory, workable in practice, and the result of naval experience. For if it is well adapted to the requirements of the Post Graduate School, it ought to be, in large measure, adapted to the studying time and the practical requirements of naval officers throughout the service.

Theory of the Course

Each student is assigned a definite, practical objective. This objective is an article on a professional subject, so written as to be acceptable, if not more than acceptable, for publication in the Naval Institute Proceedings, the *Journal of the American Society of Naval Engineers,* or any other magazine devoted to articles on technical subjects, or professional subjects, either primarily or occasionally.

Each student is left free to choose his own subject, provided that he knows enough about it to make more than a minimum of research unnecessary. It is assumed that he is especially inter-

ested in the professional subject chosen, and that the subject is suited in a general way to the purposes of Exposition, as distinguished from Narration or Argument. At the third recitation, however, or one week before the class submits a revision of the first outline of the article, any student has the opportunity to change his subject.

The main work of composition throughout the course is the organization or planning, the writing, and the revision—in several stages—of the article. These successive stages in the composition of the article, though logical in their order, are not continuous. Monotony is avoided, and the student is led to return with more enthusiasm to the writing of the article, by the assignment of intermediate stages of study and practice. Each intermediate stage leads up to the next main task of composition.

Although the course is based upon a similar one given to the post graduate student officers in 1917, it has been revised in the light of experience. Nevertheless, the exaggeration of the mechanical aspect of structure in the Whole Composition and the Paragraph is deliberate, and has been found to be effective.

The first part of the course deals with the Whole Composition—its purpose, organization, convergence, and conclusion. In the very first lesson assignment, the class is directed to submit three statements: (1) The title of the article; (2) The reason for writing the article—a brief explanation of the effect or result desired; (3) The conclusion of the article—that is, a preliminary draft of the final paragraph. This method is similar to the statement of the *Mission* as the first stage in the ***Estimate of the Situation***, as conducted at the War College (see Naval War College Pamphlets, Series 1, No. 2: Estimate of the Situation, by Rear Admiral Austin M. Knight, U. S. Navy, published by the U. S. Naval Institute, April, 1915).

Assuming that the course must be planned for not more than fourteen hours, the successive stages of the course, in their order and time allotment, are as follows:

1. The Whole Composition, 4 recitations.
2. The Paragraph, 4 recitations.
3. The Sentence, 3 recitations.
4. The Word, 3 recitations.

If, however, more than fourteen hours should be available, the additional recitations would be devoted to the third stage, The Sentence, and the fourth stage, The Word. If less than fourteen hours should be available, or, for instance, eleven hours, the fourth stage would be omitted and the first three stages would receive the same number of hours, 4, 4, 3. The theory involved is that at least four hours should be spent in organizing the Whole Composition before it becomes worth while to study the division into paragraphs, and the internal structure of the Paragraph; and, likewise, that four hours should be spent in studying and revising paragraphs before it becomes worth while to take up the structure of the Sentence. This does not mean that the structure of sentences and the use of words is less important than the first two stages. It does imply, however, that for the purposes of the course, any stage except the first would be futile without the preceding and preparatory stage.

To classify the four stages, they may be considered as forming two groups, distinctively different, as follows:

Prevision: The Whole Composition and the Paragraph.

Revision: The Sentence and the Word.

This difference is made clearer if we compare it with the difference between Strategy and Tactics, by saying that Prevision in Composition corresponds to Strategy in War, and that revision corresponds to Tactics in battle. In other words, the Whole Composition and the Paragraph can be planned in advance, while the Sentence and the Word should be handled spontaneously in actual writing, at first, and afterward subjected to careful revision. "For," says Barrett Wendell, a notable master of the art of teaching composition, "there is no fact in human experience more settled than this: to do anything thoroughly well we must not stop in the act to consider how we are doing it. Action of any kind may and should be carefully planned; things once done may be and should be rigorously scrutinized. But the time to plan is before work begins; the time to criticize is after the work is done."

By the study of the Whole Composition and the Paragraph, then, the students acquire a "doctrine," or are "indoctrinated" in the principles of composition and Exposition. While it may also be said that they are indoctrinated in the principles of structure

of the Sentence; and in the use and choice of Words, they can continue the practice of writing sentences and words the rest of their lives, whereas they are not apt to study the principles of planning the whole composition and the paragraph except in a course such as the one in question, under the guidance and criticism of an instructor.

The recitation hour is divided into two parts: (1) a lecture, of thirty minutes or less; (2) a test or tests, lasting thirty minutes or more. In this way, the university lecture method is combined with the Naval Academy recitation method.

Constant use is made of mimeograph notes, not only for the sake of definiteness in instruction, but in order that the students may keep the notes permanently in their possession for future use. Indeed, the value of modern mimeographing in education has not been fully recognized. It increases to an extraordinary degree the efficiency of both teaching and learning, and enables the class to cover much more ground than they could otherwise cover in a given time. The nature of the mimeograph notes used in the course in Exposition is in general as follows: Lesson schedules, issued a few days in advance of the recitation; notes on structure, with concrete examples for illustration; outlines of all lectures, given out after the lecture; folded sheets, with test questions on one side and answers to questions on the reverse side.

In correcting the first draft of the article (handed in at the sixth hour), attention is paid solely to the division into paragraphs, and transitions between paragraphs. The second draft, in which the student is concerned mainly with the internal structure of each paragraph, is corrected exclusively for such structure. The third and the fourth drafts, each one being a revision of half of the article for sentence structure, are corrected for sentence structure only. The final draft, submitted at the last hour of the course, is written and corrected with regard, exclusively, to the use of words, their selection, their number, and their combinations or phrasing.

Serious errors of form are corrected throughout the course, but these corrections are made in blue pencil, to distinguish them from rhetorical corrections, made in red pencil. This apparently trivial detail is intended to make clear the fact that corrections of form (spelling, grammar, punctuation) are decidedly less important than rhetorical corrections. The class is told that

corrections of form are subsidiary to rhetorical criticism, that the former will be reduced to a minimum, and that the marks assigned will be based almost entirely upon the proficiency with which the students apply the larger principles.

The three textbooks upon which the lesson assignments are based are used mainly as material for exercises and examples, both in preparation, and during the recitation hour. They are very different in purpose, and are combined to give the class a broader point of view than any one textbook could offer. Of the three books, the one most frequently used, because it consists mainly of examples of Exposition, is Fulton's *Expository Writing*, (the MacMillan Company, 1912). The others are Stevens and Alden's *Composition for Naval Officers* (the Lord Baltimore Press, 1919), and Woolley's *The Mechanics of Writing* (D. C. Heath & Company, 1916).

Although lack of space forbids a description of the lessons, lectures, and tests in detail, a list of the lecture subjects and of the authors whose writings are studied in Fulton's text-book will give a general idea of the methods used.

TITLES OF LECTURES

1. Unity: Limitation and Convergence; the Conclusion.
2. Coherence: Order and Sequence; Transitions.
3. Clearness: Proportion and Emphasis; Subheadings.
4. Interest: Concreteness: Comparison; Illustration.
5. What Is a Paragraph?
6. Similarities in Structure between the Whole Composition and the Paragraph.
7. The Paragraph as a Mechanism.
8. Deductive and Inductive Paragraphs.
9. The Pre-Determination of Sentences: Parallel Construction and Transition.
10. Similarities in Structure between the Paragraph and the Sentence.
11. The Sentence as the Focus of Structural Principles.
12. The Principles of Word Choice.
13. Accuracy in Words: The Bearing of Etymology on Accuracy.
14. Good Use and Vocabulary: The Habit of Word Criticism and Word Observation.

Of the examples of Exposition studied and analyzed, the following are characteristic:

A selected article in the NAVAL INSTITUTE PROCEEDINGS.

What Is Education? Huxley.

Refining Crude Petroleum. Tower. (*The Story of Oil.*)

The Importance of Dust. Wallace. (*The Wonderful Century.*)

On Yeast. Huxley.

Americanism: An Attempt at a Definition. Brander Matthews. (*Parts of Speech.*)

The Relativity of All Knowledge. Spencer. (*First Principles.*)

The Ideal Historian. Macaulay. (*Essay on History.*)

Literature. Cardinal Newman. (*The Idea of a University.*)

The Chemist in the Industries. Richardson.

The Web-foot Engineer. Brooks.

Two Kinds of Education for Engineers. Johnson.

Racial Elements of English Character. Matthew Arnold. (*On the Study of Celtic Literature.*)

The Value of Education in Science. Mill. (*Discussions and Dissertations.*)

Equality. James Bryce.

The Rhythm of Motion. Spencer. (*First Principles.*)

Modern Chemistry and Medicine. Richards.

The Problems of Astronomy. Newcomb.

Stephen B. Luce: An Appreciation. Rear Admiral Bradley A. Fiske, U. S. Navy, (reprinted by permission from the Naval Institute).

The British Navy at the Time of the American Revolution. Rear Admiral French Ensor Chadwick, U. S. Navy, (abridged from the Introduction to *The Graves Papers, and Other Documents Relating to the Naval Operations of the Yorktown Campaign.* Reprinted by permission of the Naval History Society).

For variety, and more informal illustration of principles, certain reference books are in addition placed at the disposal of the class. Among these are:

Sea Warfare. Rudyard Kipling.

Elements of the Great War: The Battle of the Marne. Hilaire Belloc.

The Grand Fleet, 1914-1916, Its Creation, Development, and Work. Admiral Viscount Jellicoe of Scapa.

Copies of recent numbers of *The World's Work.*

The Ship That Found Herself, Steam Tactics, A Fleet in Being, etc. Kipling.

In conclusion, the following reproduction of the folded mimeograph sheet used for the test during the first hour of the course will indicate the nature of the tests assigned:

UNITED STATES NAVAL ACADEMY POST GRADUATE DEPARTMENT

COURSE IN EXPOSITION

THE WHOLE COMPOSITION—I TOPIC CARD TEST

1. Each student is given a shuffled pack of cards. The pack contains 20 cards, and each card contains a topic sentence taken from an article in the NAVAL INSTITUTE PROCEEDINGS for March, 1919, entitled:

"SOME IDEAS ABOUT THE EFFECTS OF INCREASING THE SIZE OF BATTLESHIPS"

2. The article in question contains 79 paragraphs. These paragraphs are grouped under six main divisions or main headings, including the Foreword and the Conclusion. There are thus six main topics and seventy-nine sub-topics, or eighty-five topics in all. As the majority of the paragraphs are very short, and deal with minor details, the selection of twenty topics for this test is sufficient to give a clear idea of the outline of the article. The topic sentences representing the six main divisions are included in the pack of cards.

3. *Problem.*—(1) Arrange the cards in logical order. Time allowed: fifteen minutes. (2) Select the six cards which you think represent the six main topics of the article (1. Foreword; 2. First Main Topic; 3. Second Main Topic; 4. Third Main Topic; 5. Fourth Main Topic; 6. Conclusion). Write these six main topics down in outline form on theme paper. Time allowed: ten minutes. (3) Compare your outline with the key on the folded side of this paper.

........................(Fold on this line)........................

KEY TO TOPIC CARD TEST

Full Outline for Cards

I. Foreword: Shipbuilding . . . . is a matter of continuous progress.

II. The Qualities of Naval Ships . . . .
  1. Useful displacement is apportioned according to intended service.
  2. The total displacement . . . . is made up of the following . . . .

III. Battleships Considered Singly . . . .
  1. Armament.
  2. Protection.
  3. Mobility . . . . (Of all the qualities which a battleship should have, none is more disputed than that part of mobility which speed supplies.)
  4. Endurance.

IV. Probable Limits of the Size of Battleships.
    1. The locks of the Panama Canal . . . . should take a ship 980 feet long and 110-foot beam.

V. Numerous Battleships Considered Together.
    1. Coördination of available forces is employed in two principal ways, *i. e.,* strategy and tactics.
    2. The tactical considerations involved . . . .
    3. Considerations of strategy . . . .
    4. Certain economic considerations . . . .

VI. Conclusion:
    1. Summary: The battleship of increased size, considered singly, can carry more fighting power, be protected for more effective resistance, have higher speed under all conditions, greater radius of action, and greater cruising life.

       Battleships of increased size, considered together, are of greater tactical value, of greater strategic value, and of greater economic value.
    2. The decision is definitely in favor of the battleship of increased size.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE IDENTIFICATION OF STARS IN CLOUDY WEATHER

By Captain Armistead Rust, U. S. Navy

1. An unknown star may be readily identified by means of the Star Identification Tables (H. O. Publication No. 127) when its altitude and azimuth have been observed. In cloudy weather, however, at night, when there is much motion on the ship and particularly when the altitude of the star is high, it is not convenient to obtain a compass bearing of the star.

For the purpose of star identification the azimuth may be obtained, without the use of the compass, from two observed altitudes as shown below.

From formula 285 of Chauvenet's Trigonometry (10th edition), we have:

$$\Delta h = \cos Z \Delta L + \cos M \Delta d - \cos L \sin Z \Delta t. \qquad (1)$$

Let L and d be constant, then:

$$\Delta h = -\cos L \sin Z \Delta t. \qquad (2)$$

If $\Delta t = 1$ minute of time $= 15'$ of arc, we have:
Rate of change of altitude in 1 minute,

$$\Delta h_1 = R_m = -\cos L \sin Z, \qquad (3)$$

hence,

$$\sin Z = -\frac{R_m}{15} \sec L. \qquad (4)$$

R_m may be found from the difference between two altitudes, observed in quick succession, expressed in minutes and decimals, divided by the interval between the observations in minutes and decimals of time. To be exact, unless the ship be on a course at right angles to the bearing of the body, the rate of change of altitude in one minute, R_m, found by observation must be corrected for the run of the ship; that is, if K minutes is the speed of the ship per hour, then K seconds is the speed per minute and the correction $= K'' \cos (C \sim Z)$, where $C =$ course and $Z =$ azimuth of the body, which is found by using the observed rate of change per minute and Plate I. Enter the Traverse Tables with K'' as

a distance and $(C \sim Z)$ as a course, then the correction is found as a difference of latitude, to be subtracted from the observed change of altitude per minute when the ship is moving towards the body, and to be added when moving away from the body; in other words, when $(C \sim Z)$ is less than 90°, subtract; when $(C \sim Z)$ is greater than 90°, enter with the supplement of $(C \sim Z)$ and add the correction. The above rules apply when the body is rising; when falling, add when approaching, and subtract when separating. As a rule, this correction is not necessary for finding the approximate azimuth for the identification of stars, except in very fast ships whose courses are nearly towards or away from the observed body.

After finding R_m find the azimuth from Plate I by taking R_m on a vertical scale, the intersection of the horizontal line through this point with the curve corresponding to the latitude of the ship fixes a vertical line which determines the azimuth at the bottom or top of the diagram, depending upon the compass quadrant in which the body lies, and this should be noted roughly at the time the altitudes are observed. The enlarged part of Plate I is for altitudes near the meridian.

2. To find the hour angle of the star from Table I:

TABLE I.—FOR FINDING THE HOUR ANGLE

GIVEN THE ALTITUDE AND AZIMUTH OF THE STAR AND THE LATITUDE OF THE OBSERVER

A		2°	3°	7°	18°	19°	32°	58°	71°	72°	83°	87°	88°	B
°	D	1	2	4	12	13	24	60	109	115	298	669	969	D′
37	79		0.1223											°
	110							0.1193						68°
37	79											8.8022		
	514						8.8010							4°18′
55	81	9.8448												
	104									9.8414				66°
55	81												8.3880	
	1250				8.3963									1°30′
57½	83			9.8011										
	94								9.8011					63°
57½	83										8.8901			
	460					8.8907								4°42′

NOTE.—In the complete table the angles in columns A and B, and in the headline AB, are given for every ½°; the logarithmic differences are given in column D and headline DD′, so that interpolation may be made for the odd minutes with ease when extreme accuracy is required. For identifying stars this is not necessary.

Table I was computed with a view to having a compact Time-Azimuth Table for all latitudes and declinations and for finding the great circle courses when the distance is not known, as well as for finding the hour angle in star identification; in other words, it was designed to solve the following equations:

$$\text{Cot } \tfrac{1}{2}t \cos \tfrac{1}{2}(L \sim d) = \cos \{90^\circ - \tfrac{1}{2}(L+d)\} \tan \tfrac{1}{2}(Z+M). \quad (5)$$

$$\text{Cot } \tfrac{1}{2}t \cos \{90^\circ - \tfrac{1}{2}(L \sim d)\} = \cos \tfrac{1}{2}(L+d) \tan \tfrac{1}{2}(Z \sim M). \quad (6)$$

$$\text{Cot } \tfrac{1}{2}\lambda \cos \tfrac{1}{2}(L_1 \sim L_2) = \cos \{90^\circ - \tfrac{1}{2}(L_1+L_2)\} \tan \tfrac{1}{2}(C_1+C_2). \quad (7)$$

$$\text{Cot } \tfrac{1}{2}\lambda \cos \{90^\circ - \tfrac{1}{2}(L_1 \sim L_2)\} = \cos \tfrac{1}{2}(L_1+L_2) \tan \tfrac{1}{2}(C_1 \sim C_2). \quad (8)$$

$$\text{Cot } \tfrac{1}{2}Z \cos \tfrac{1}{2}(L \sim h) = \cos \{90^\circ - \tfrac{1}{2}(L+h)\} \tan \tfrac{1}{2}(t+M). \quad (9)$$

$$\text{Cot } \tfrac{1}{2}Z \cos \{90^\circ - \tfrac{1}{2}(L \sim h)\} = \cos \tfrac{1}{2}(L+h) \tan \tfrac{1}{2}(t \sim M). \quad (10)$$

Here we are concerned with formulas (9) and (10) only, and the altitude, h, is always given the same name as the latitude, L.

To find the hour angle, given the true altitude and azimuth of the star, from the elevated pole, and the latitude of the observer.

Enter Table I with $\tfrac{1}{2}Z$ in column A, and opposite $\tfrac{1}{2}Z$ and under $\tfrac{1}{2}(L \sim h$ in the headline AB take out log X; under $90^\circ - \tfrac{1}{2}(L \sim h)$ in the headline AB find this log X, and take out the angle X opposite in column B.

Opposite $\tfrac{1}{2}Z$ in column A and under $90^\circ - \tfrac{1}{2}(L-h)$ in the headline AB take out log Y; under $\tfrac{1}{2}(L+h)$ in headline AB find log Y and the corresponding angle, Y, opposite in column B.

Then, when $L > h$ we have, $t = X + Y$, and when $L < h$ we have, $t = X - Y$.

HOUR ANGLE FROM AZIMUTH TABLES

3. As Table I contains about 36 pages it is too long to reproduce here, nor is it necessary for the purposes of this paper, as the Azimuth Tables may also be used for finding the hour angle of a star when its altitude and azimuth are given when the Star Identification Tables are not available. Table I is shown in skeleton form to indicate its use.

To find the hour angle:

Enter the Azimuth Tables in the latitude of the ship with the azimuth as an hour angle and the altitude as a declination; the corresponding azimuth is the hour angle of the star.

In order to find the hour angle from the Azimuth Tables it is necessary to first determine the name of the declination, which may

be readily done from Table II, for which the writer is indebted to Commander H. L. Rice, Professor of Mathematics, U. S. Navy.

TABLE II.—VALUES OF Q

Altitudes	For azimuths North toward West or North toward East										Altitudes
	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	
°	°	°	°	°	°	°	°	°	°	°	°
10	16.0	16.0	15.9	15.7	15.4	14.9	14.1	12.5	8.9	0.0	10
20	14.0	13.9	13.8	13.4	12.9	12.1	10.8	8.6	5.1	0.0	20
30	12.0	11.9	11.7	11.3	10.6	9.6	8.2	6.1	3.3	0.0	30
40	10.0	9.9	9.6	9.2	8.5	7.5	6.2	4.4	2.3	0.0	40
50	8.0	7.9	7.7	7.2	6.5	5.7	4.6	3.2	1.7	0.0	50
60	6.0	5.9	5.7	5.3	4.8	4.1	3.2	2.2	1.1	0.0	60
70	4.0	3.9	3.8	3.5	3.1	2.6	2.1	1.4	0.7	0.0	70
80	2.0	2.0	1.9	1.7	1.5	1.3	1.0	0.7	0.4	0.0	80
90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	90
	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	
Altitudes	For azimuths South toward West or South toward East										Altitudes

Express the latitude in degrees and tenths as Q in the table.
Mark North latitude + and South latitude —.
When the azimuth is found at the top of the table, Q is +.
When the azimuth is found at the bottom of the table, Q is —.
The declination has the sign of $Q + \frac{\text{latitude}}{5}$.

TO FIND THE DECLINATION

4. After finding the hour angle the declination is readily found from Plate II by entering with the azimuth on a vertical margin; the intersection of the horizontal line through this point with the altitude curve of the body, numbered at the top of the diagram, fixes a vertical line, the intersection of which with the horizontal line through the hour angle, taken on a vertical scale, determines the declination of the body, which is marked N. or S., as shown by Table II.

From the local sidereal time subtract the hour angle when West, or add it when East, the result is the right ascension of the star, so that having both the right ascension and the declination the star can be found with certainty in the star list.

Example 1.—At sea, August 10, 1904, in Lat. 11°37′ N., Long. 81°09′ W., about 5.30 a. m., observed two altitudes of a bright star

through a rift in the clouds, bearing to the S'd and E'd, altitude cor.—9'; G. S. T. of 2d observation $8^h12^m17^s$.

As the ship was rolling heavily at the time no accurate bearing could be taken. What star was observed?

	Watch times		Obs. altitudes
	$5^h33^m23^s$		$25°33'$
	5 35 43		26 04
Interval	2 20	Diff.	31

$31' \div 2\tfrac{1}{3} = 13.3' = R_m$. From Plate I, $Z = \text{N. } 115°$ E.

$$X\begin{cases} \text{(a)} & \tfrac{1}{2}Z = 57°30'. \\ \text{(b)} & \tfrac{1}{2}(h-L) = 7°09'. \\ \text{(c)} & 90° - \tfrac{1}{2}(L+h) = 71°14'. \end{cases}$$

. . . .

$$Y\begin{cases} \text{(a)} & \tfrac{1}{2}Z = 57°30'. \\ \text{(d)} & 90° - \tfrac{1}{2}(h-L) = 82°51'. \\ \text{(e)} & \tfrac{1}{2}(L+h) = 18°46'. \end{cases}$$

Proceed as directed in paragraph 2 and we find: Log $X = 9.8011$, and $X = 63°$. Also, log $Y = 8.8901$, and $Y = 4°42'$.

As $L < h$, then $t < M$ and $t = X - Y = 58°18' = 3^h53^m12^s$.

Note that in the groups for finding X and Y, (a) is the same in both, and (d) and (e) are the complements of (b) and (c) respectively.

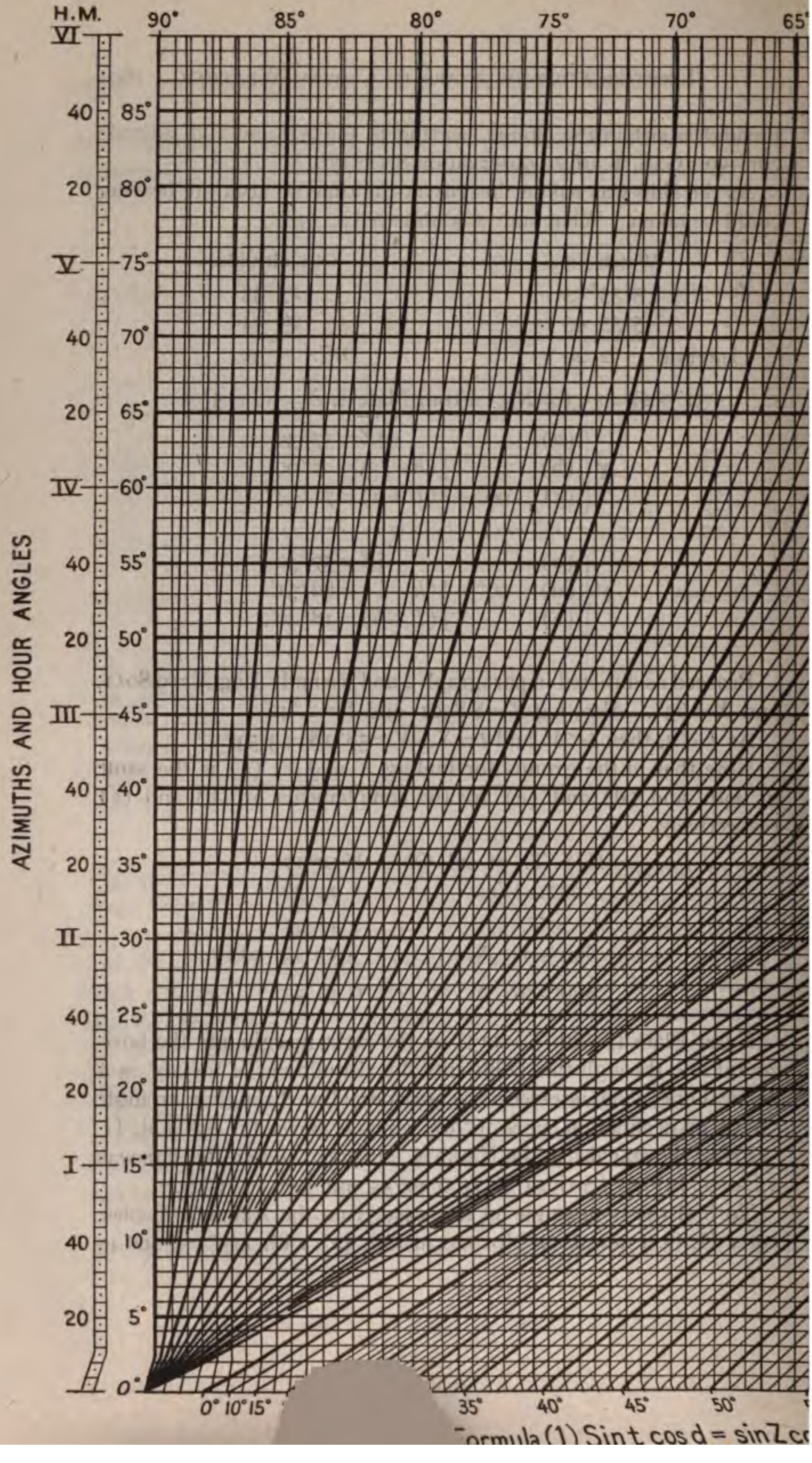
G. S. T. of 2d Obs.	$8^h12^m17^s$
Long., West	5 24 36
L. S. T.	2 47 41
Star's H. A. $= t$	3 53 12, add.
Star's R. A.	6 40 53

Enter Plate II with $Z = 115°$ on the right margin and the horizontal line through this point cuts the altitude curve for 26° in a vertical line which intersects the horizontal line through hour angle 58° 18' on declination curve 16° 30', which is marked S. by Table II.

From the star list in the Nautical Almanac we find the star was α Canis Majoris (Sirius), R. A. $6^h40^m55^s$ and dec. 16° 35' S.

To find the hour angle in this case from the Azimuth Tables, enter H. O. Publication No. 120 in Lat. 12° with $115° = 7^h40^m$ in

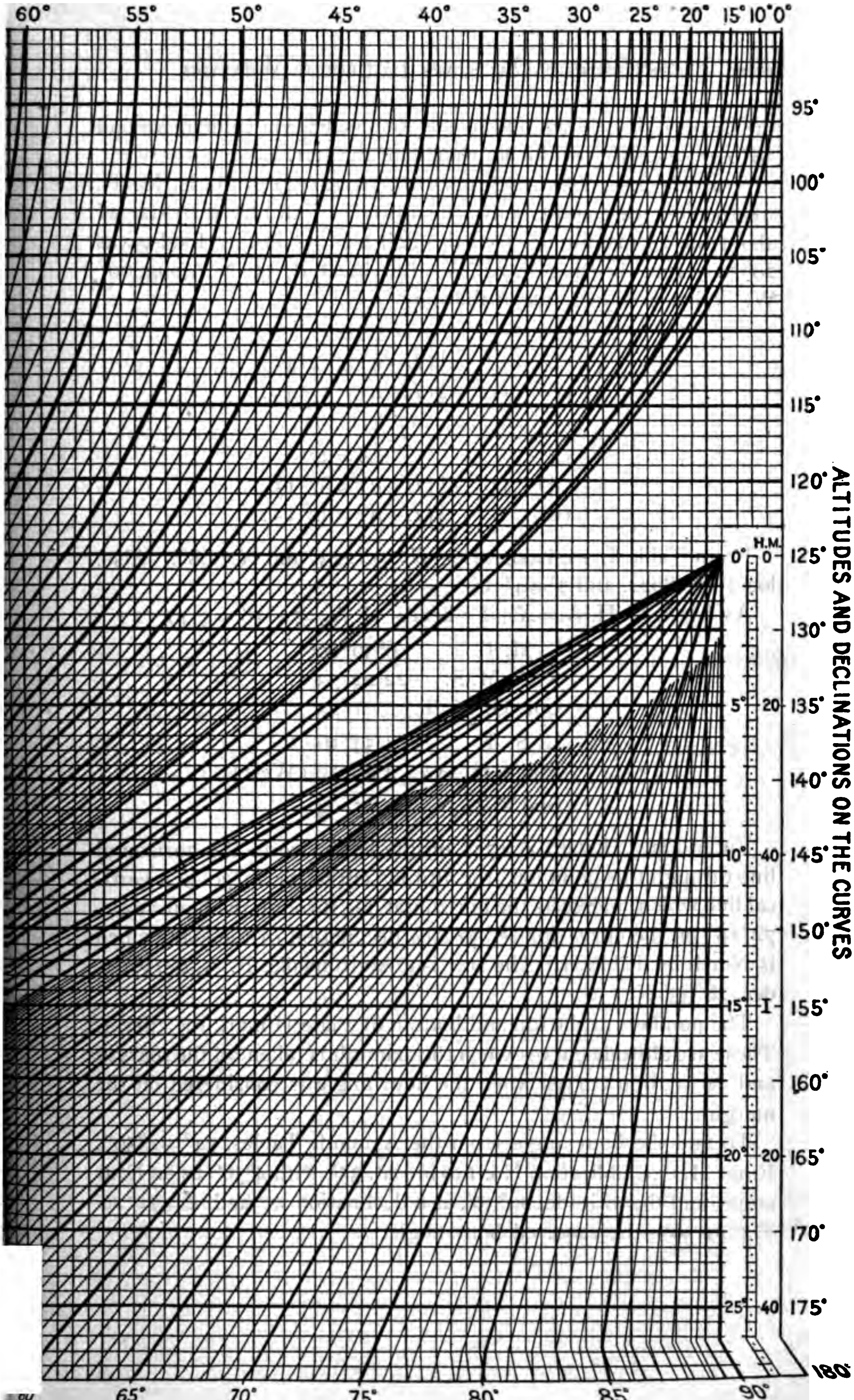
RUSTS AZIMUTH, STAR-FI



ormula (1) Sin t cos d = sin Z c

S AND GREAT CIRCLE DIAGRAM

PLATE II.



ula (2) $\sin\lambda \cos L_2 = \sin C . \cos(90^\circ - D)$

the hour angle column, and in the 26° declination column we find $58°04' = 3^h52^m16^s$ for the hour angle of the star.

Example 2.—At sea, February 26, 1901, 6.30 p. m., L. M. T., weather overcast and cloudy; the altitude of an unknown star of about the 2d magnitude, seen through a break in the clouds, was 29° 30′ (true), bearing N. 74° W. Lat. by D. R. 35° N., Long. 60° W. What was the name of the star?

$$X\begin{cases} \text{(a)} & \tfrac{1}{2}Z = 37°. \\ \text{(b)} & \tfrac{1}{2}(L-h) = \ 2°45'. \\ \text{(c)} & 90° - \tfrac{1}{2}(L+h) = 57°45'. \end{cases}$$

....

$$Y\begin{cases} \text{(a)} & \tfrac{1}{2}Z = 37° \\ \text{(d)} & 90° - \tfrac{1}{2}(L-h) = 87°15'. \\ \text{(e)} & \tfrac{1}{2}(L+h) = 32°15'. \end{cases}$$

From Table I, we have: Log $X = 0.1223$, and $X = 68°$. Also, log $Y = 8.8022$, and $Y = 4°18'$.

As $L > h$, $t = $ H. A. $= X + Y$; hence, H. A. $= 72°18' = 4^h49^m12^s$.

L. M. T.	$6^h30^m00^s$
R. A. M. S.	22 22 33
Cor. G. M. T.	1 43
L. S. T.	4 54 16
Star's H. A.	4 49 12 (West)
Star's R. A.	0 05 04

Enter Plate II with $Z = 74°$ on the left margin, the horizontal line through this point cuts the altitude curve for 29° 30′ in a vertical line which intersects the horizontal line through the hour angle, 72° 18′, on the curve for 28° 30′, the declination of the star, which is North by Table II. The star is α Andromedæ, R. A. $0^h03^m19^s$, dec. 28° 33′ N.

The numbers at the top and bottom of Plate II mark the curves. These are altitude curves when the azimuth is taken on the margin and declination curves when the hour angle is considered on the margin.

To find the hour angle from the Azimuth Tables, $74° = 4^h56^m$. Enter H. O. Publication No. 120 in Lat. 35° with 4^h56^m as an hour angle, and the altitude, 29° 30′, as a declination we find, $Z = 72°24' = 4^h49^m36^s$—the required hour angle.

Example 3.—At sea, February 6, 1903, Lat. 16° S., Long. 38° 12′ W., observed the following altitudes of a star to the N'd and W'd. Cloudy weather with a heavy sea so that no accurate bearing could be taken by compass. What star was observed? Ans. α Leonis.

Obs. alts.	W. t.	
20° 18′	$5^h05^m07^s$	C—W $=3^h08^m13^s$
19 39	5 08 00	Chro. fast of G. M. T., $0^h20^m13^s$
		Altitude correction, $-7'$.

In 2^m53^s change in altitude $=39'$ and $R_m=13.52'$, and from Plate I $Z=$ S. 110° 30′ W.

$$X\begin{cases}(a) & \tfrac{1}{2}Z=55°15'.\\ (b) & \tfrac{1}{2}(h-L)=\ 2°.\\ (c) & 90°-\tfrac{1}{2}(L+h)=72°.\end{cases}$$

. . . .

$$Y\begin{cases}(a) & \tfrac{1}{2}Z=55°15'.\\ (d) & 90°-\tfrac{1}{2}(h-L)=88°.\\ (e) & \tfrac{1}{2}(L+h)=18°.\end{cases}$$

From Table I: Log $X=9.8448$ and $X=66°$. Log Y=8.3880 and Y=1° 30′.

As $L<h$ then $t=X-Y=64°30'$, or hour angle $=4^h18^m$.

From Plate II with $Z=110°30'$, $h=20°$ and hour angle 64° 30′, we find the declination, 12° 30′, marked North by Table II.

w. t. (mean)	$5^h06^m33^s$
C—W	3 08 13
Chro.	8 14 46
Chro. cor.	− 20 09
G. M. T., Feb. 5	19 54 37
R. A. M. S.	20 57 50
Cor. G. M. T.	3 16
G. S. T.	16 55 43
Long., West	2 32 48
L. S. T.	14 22 55
Star's H. A.	4 18 00
Star's R. A.	10 04 55

To find the hour angle from the Azimuth Tables, enter H. O. Publication No. 71, Lat 16°, dec. 20°, contrary name. We find

that the hour angle, $7^h22^m = 110°30'$, is not given, so we enter with the supplement of this hour angle, 4^h38^m and the supplement of the corresponding azimuth, $115°30'$, or $64°30' = 4^h18^m$, is the hour angle required.

The right ascension and declination here found correspond to α Leonis (Regulus).

After finding the hour angle and declination enter the Azimuth Tables with these to see whether the azimuth so found agrees with that given, thus verifying the work.

5. When the star is on or very near the meridian, so that its hour angle is practically 0, the star's right ascension may be assumed equal to the local sidereal time and its declination may be readily found by applying its zenith distance to the latitude by dead reckoning.

6. The writer has found Plate II very convenient for finding the altitude at which to set the sextant in order to pick up a particular star in the early evening twilight, or to find Venus or Jupiter by day.

From the local apparent time, at which it is desired take the observation, find the local sidereal time, to which apply the star's right ascension to obtain its hour angle and take its azimuth from the tables.

Enter Plate II with the hour angle on the margin; the intersection of the horizontal line through this point with the declination curve of the body fixes a vertical line, the intersection of which with the horizontal line through the given azimuth determines the altitude curve of the star.

Example 4.—In the early evening twilight, at sea, February 26, 1901, Lat. 35° N., Long. 60° W., what was the altitude of α Andromedæ at 6.30 p. m., L. M. T., when the star's hour angle was $4^h49^m12^s$ and its azimuth N. 74° W.? Star's declination 28°30′ N.

From Plate II the altitude was 29°30′. Set the sextant to this altitude and at the proper time by watch sweep the horizon over the pelorus set at N. 74° W. Thus the reflected image of the star may be easily seen on the horizon long before the eye can catch the direct image in the sky.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

FUELING AT SEA

By COMMANDER H. C. DINGER, U. S. Navy

In time of war the question of fuel supply for patrol, convoy, and scouting vessels, and for all men of war operating on extensive overseas operations becomes most important. It is unhandy, dangerous, and sometimes impossible to go to a port to refuel, and, therefore, the problem of fueling at sea requires a solution. In smooth water, the problem of taking on board either coal or oil becomes quite simple, but it is at times undesirable to stop the vessels en route, and a dead calm is not always at hand. What is desired is to fuel vessels while underway at fair speed in an ordinary swell or seaway. This can and has been done.

In a dead smooth sea, the vessels can be taken alongside and tied up much the same as in port, but if there is any swell or seaway, this is dangerous. To accomplish the transfer of fuel in anything but a smooth sea, one of the vessels must be towed.

Numerous experiments have been made with special coaling at sea gears, in which the vessel taking the coal is towed by the fuel vessel, and the coal is carried by a special cableway, from the stern of the collier to the forecastle of the vessel. These installations require a great deal of special gear, and require a long space of time to rig, and the rate of delivery is so slow that this system is impractical, and is not used in actual practice. The files of the PROCEEDINGS of the Naval Institute contain several accounts of such coaling-at-sea experiments. In general, the transfer of fuel by towing astern has not been a practical success. There is an alternative method, towing abreast, which has much greater promise of success, and requires little or no extra gear on the fuel vessel, and no extra gear or attachments on the vessel receiving the fuel.

It is a comparatively easy operation to take a vessel in tow abreast and maintain her position—a steady almost exact posi-

tion—well clear of the side. With a vessel maintained in this position, coal can be transferred by bags from boom ends, or by means of movable pipes from fuel vessels fitted with coaling towers. A coaling tower is a device operating a self-filling bucket chain, or coal elevator. The coal being dumped at the top of the tower into a hopper, from which coal pipes are led to the point where coal is to be landed. These devices have been used successfully for years on coal barges, and for unloading ore, sulphur, etc. The bucket chain is adjustable, and end can be lowered as necessary into the hold. The coaling tower can be mounted on tracks, so as to be capable of being moved to any point of the coal hold. Designs of these towers have been prepared, which are adaptable to naval colliers. Two or three of such towers, each operated by an electric motor, would replace all the elaborate winch, bucket and derrick gear now fitted to our naval colliers; and would be a big improvement in cost of operation as well as safety.

With these coaling towers, coaling might be accomplished through flexible tubing, which would be almost the same thing as coaling through a hose.

As far as is known, the first actual oiling of vessels at sea in rough weather was done by the U. S. S. *Maumee* in May, 1917, when a division of destroyers was oiled on the way across the Atlantic.

The gear used was as follows:

A 10-inch manila line was led from the bow of the fuel vessel, taken outboard and stopped along the rail; a 2-inch messenger was bent on the end. Two 6-inch breast lines were provided with heaving lines. Two 3-inch lines of oil hose were connected to the oil line, and were supported on a wooden carrier suspended from boom end, the line supporting this carrier being led to a winch, and tended by winch man.

The manner of coming alongside, taking lines, etc., is indicated in the instructions prepared for the occasion, quoted as follows:

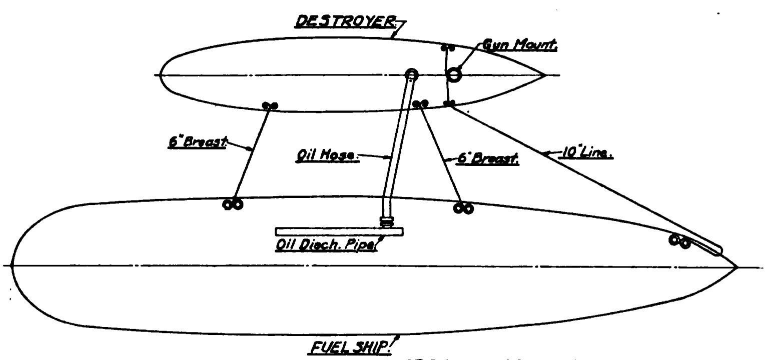
PREPARED ON U. S. S. "MAUMEE" FOR GUIDANCE OF DESTROYERS OILING AT SEA

1. *Gear.*—All supplied by fuel ship.

10-Inch Bow Spring.—This line is led from the bow of the fuel ship and stopped along the rail; a 2-inch messenger is bent on about 50 feet from

end and stopped along to end. This line should be taken in on destroyer bow through bitts just forward of bridge. Take messenger to capstan and assist handling by hand; cut stops as they come to bitts. Take turn around base of gun mount as indicated on sketch and secure end to bitts on opposite side. Be sure that hawser is secure around base so that it will not ride up on mount. As soon as end is secured notify fuel ship, which will then heave in to place destroyer in proper position. Put lashings around and over bitts to prevent hawser jumping.

2. *Breast Lines, 6-Inch.*—Forward, take in through bitts forward of forward gun, then to bitts forward of capstan. Do not secure to capstan as it may be damaged. This line *must* be securely fastened as a very heavy strain may come on it.



ARRANGEMENT OF LINES AND OIL HOSE FOR OILING DESTROYERS AT SEA.

3. *After Line.*—Take through bitts in wake of deck house, secure, and stand by to tend.

4. *Hose.*—The hose, two lines, are led together through a wooden carrier supported from boom. Near end of hose, there is a wooden yoke to which is attached a handling line. The hose should be handled on board destroyer with this line, not with end of hose. Rail should be broken down and clear where hose is taken on board. Get ends of hose and hose yoke on destroyer, secure yoke and then put ends of hose in tanks. Pumping will start as soon as destroyer reports ready.

5. *Handling of Destroyer.*—Come along on parallel course, speed about 8 knots, distance about 50 feet from fuel ship; slow down to keep abreast fuel ship, ease in or out as necessary, but do not drop aft too far and get under counter. When 10-inch spring is fast, drop down on it slightly and let fuel vessel take in on breast lines till desired position is reached. about

40 feet from side, then maintain about 4 knots, just keeping slight or occasional strain on 10-inch spring. Destroyer will then ride to 10-inch spring and forward breast. Do not head out suddenly as this will break away the forward breast. Speed up if necessary to take strain off 10-inch spring and keep from swinging in too close.

The breast lines keep the destroyer in and prevent hose being carried away. Destroyers can come abreast and make connections in moderate sea without danger if precautions mentioned are adhered to. The principal danger is coming too close and throwing stern in. There is a suction under counter and destroyer should keep out of this. A speed of about 5 knots is maintained by fuel ship. This is necessary in order to steady fuel vessel and enable her to steer a straight course. The fuel vessel must

DESTROYER COMING ALONGSIDE.

steer a straight course; rolling is not objectionable, but yawing is,—hence sea should be abeam or slightly forward of beam.

6. Before coming alongside destroyer should have her forecastle clear, rail clear for hose, have lashings ready, capstan ready and men instructed where the lines are to be led. Lines must be very securely fastened.

In smooth weather one destroyer can be taken on each side, and in calm, destroyers can make fast and receive oil as in port.

The first time that this was tried was in a moderate sea, as the attached photograph will indicate. The destroyers were each oiled in about two hours, and oil was delivered at from 30,000 to 40,000 gallons an hour. In some cases destroyers were connected up and oil being pumped on board in 15 minutes from the time the destroyer passed the stern of fuel vessel, this being done with a

DESTROYER OILING, VIEW FROM DECK OF FUEL VESSEL.

DESTROYER ALONGSIDE OILING—VIEW FROM BRIDGE OF FUEL VESSEL.

vessel that had never previously gone through the operation. With practice, a destroyer could no doubt connect up in 10 minutes.

In rough sea the fuel vessel makes a lea, taking sea a little forward of beam. In smooth weather a destroyer can be taken on each side while steaming 8 to 10 knots, one vessel connecting up while the other is having oil delivered. When towing abreast, both vessels are entirely and instantly under full control of their engines and helm. Lines can be cast adrift without danger of fouling screws. The whole operation can be viewed by the captain from the bridge of each vessel, and the two vessels are in direct verbal communication *all* of the time that they are close to each other. In towing astern or from the quarter, this is not the case, and unless the officer in control of either vessel can see fully what the other is doing, difficulties are likely to be presented.

With fuel vessels thus arranged as mentioned above, a fleet can maintain the sea indefinitely. Fueling cannot be attempted in very rough weather, but a fairly smooth sea can usually be found in the course of several days, except in specially tempestuous waters.

The method employed with destroyers can be used for much larger vessels, though perhaps it could not be done in as rough a sea.

U. S. NAVAL INSTITUTE

SECRETARY'S NOTES

Change in Board of Control

Captain David Potter PC., U. S. Navy, tendered his resignation as a member of the Board of Control, and his resignation was accepted by the Board with regret on August 12, 1919.

Membership

Life, regular and associate membership, 5652. New members: 7. Resignations: 27. Dropped: 9. Deaths: (15)

Lieut. Commander R. O. Baush, U. S. N.
Lieut. Commander Richard M. Elliot, U. S. N.
Lieut. F. D. Blakely, U. S. N.
Midshipman R. G. Campbell, Jr., U. S. N.
Lieut. T. T. Bower, U. S. N.
Ensign S. S. Cutler, U. S. N.
Lieut. J. S. Spaven, U. S. N.
Lieut. J. W. Gale, U. S. N. R. F.
Ensign W. E. Bingham, U. S. N. R. F.
Lieut. Theodore Andersen, U. S. N.
Captain R. C. Bulmer, U. S. N.
Commander F. R. King, U. S. N.
Lieut. W. F. McWhirk, U. S. N.
Major E. A. Perkins, U. S. M. C.
Commodore C. G. Bowman, U. S. N.

Dues

The annual dues ($2.50) for the year 1919 are now payable.

Regular and associate members of the U. S. Naval Institute are subject to the payment of the annual dues until the date of the receipt of their resignation.

Address of Members

All members are urged to keep the Secretary and Treasurer informed of the address to which PROCEEDINGS *are to be sent, and thus insure their receipt.*

Members and subscribers are urged to notify the Secretary and Treasurer promptly of the non-receipt of PROCEEDINGS, in order that tracers may be started. The issue is completed by the 15th of each month.

Book Department

The Institute Book Department will supply any obtainable book, of any kind, at retail price, postage prepaid. The trouble saved the purchaser through having one source of supply for all books, should be considered. The cost will not be greater and sometimes less than when obtained from dealers.

Reprints of Articles

The attention of authors of articles is called to the fact that the cost to them of reprints other than the usual number furnished, can be greatly reduced if the reprints are struck off while the article is in press. They are requested to notify the Secretary and Treasurer of the number of reprints desired when the article is submitted. Twenty copies of reprints are furnished authors free of charge.

Illustrations

Authors of articles submitted are urged to furnish with their manuscript any illustrations they may have in their possession for such articles. The Institute will gladly co-operate in obtaining such illustrations as may be suggested by authors.

Original photographs of objects and events which may be of interest to our readers are also desired, and members who have opportunities to obtain such photographs are requested to secure them for the Institute.

Notice

Whole Nos. 6, 7, 10, 13, 14, 15, 17, 145, 146, 147, 149, and 179 of the PROCEEDINGS are exhausted; there are so many calls for single copies of these numbers that the Institute offers to pay for copies thereof returned in good condition at the rate of 75 cents per copy.

ANNAPOLIS, MD., AUGUST 15, 1919.

INFORMATION INDEX

PROFESSIONAL NOTES

PREPARED BY

LIEUT. COMMANDER WALLACE L. LIND, U. S. Navy

GENERAL ARRANGEMENT

FRANCE

FRENCH NAVAL POLICY.—It goes without saying that a power's use of its colonies depends on the command of the sea. The lessons of the war have combined with the financial situation and the temporary suppression of the German Navy in completely changing the naval policy of France. Previous to the war the Republic built mainly battleships, "arbitres des batailles," and neglected scouts and other fleet auxiliaries. Gunnery was considered to be the deciding factor and speed was systematically sacrificed. To-day the bulk of French admirals favor the application by France of the famous principles of Admiral Aube, the founder of the "jeune école," who, some thirty years since, advocated that the most reliable elements of strength in a navy reside in "le nombre, la vitesse, l'invulnerabilité, la spécialization." The able Admiral Daveluy, chief exponent in France of the doctrines of Mahan, has been convinced by the war and come round to those views. He is urging the construction by France of numerous submarines, of swarms of bombing seaplanes and of the fastest destroyers and light cruisers in the world, speed having been proved the most important element of success. With the exception of England, no power enjoys a strategic position so favorable as that of France for the utilization of flotillas, especially of aviation, that instrument of control of narrow seas. Admiral Ronarch (fifty-four years of age), the glorious hero of Dixmude, is to realize the new program.—*Army and Navy Journal,* 8/16.

THE BLACK SEA MUTINY.—The Minister of Marine made an excellent speech before the House concerning the unhappy events in the Black Sea. He set himself the task of establishing the true facts with precision, and to examine into the causes with a high degree of impartiality. His clear explanations wherein his sense of his official responsibilities is attuned to his humane sense of the circumstances, are of the kind to give one a proper appreciation of the events, and also to restore calm. He concluded as follows:

"One conclusion is deduced from these facts. The events in the Black Sea must be considered from a viewpoint taking into account all the cir-

cumstances, both moral and material, which accompanied them. The attempt to debauch our crews took place at a time when France was confronted by a maximum of danger, the moment when the last peace propositions were about to be sent to our enemies.

"The men did not understand that they could become accomplices in a move which had for its aim the saving of Germany, the defrauding of France of the reparations without which she could not live,—and leaving her with nothing but her sorrows and her ruins.

"Bolshevism is a poison which Germany introduced in Russia to destroy her. The poison did its work. She set about to destroy France by the same process, but she failed. The navy remained faithful to its duty.

"We must not be weighed down by the disorder of a few hours. During the war French sailors have everywhere conducted themselves with heroism, never ceasing in their fight against the submarine, day and night. These brave ones, who have permitted France to live and to prepare for the victory, are the ones who have shown the true valor of the bluejackets.

"Two bad days do not efface nor cause forgetfulness of the four years of heroism spent in the service of the country.

"Part of the risks of war in all long conflicts are the moral and social crises which suddenly spring up. Although fatal to the conquered, the victorious peoples feel them no more than as a discomfort or as a warning.

"Indiscipline and defeat, discipline and victory are similar terms.

"Having won the war, it is necessary, in order to gain peace, to overthrow the conspiracy of evil forces loosed against France.

"The Government counts on the aid of every Frenchman to accomplish the task in which it will not fail."

At the root of all naval rebellions we *always* find one of these three complaints: insufficient food; also often the two others, too severe discipline and too long away from ashore.

Such were the complaints of the squadron of Morard de Galles which revolted in 1794 in Quiberon Bay; such were those of the British fleet in February, 1797, when it had just barely averted the terrible menace resulting from the French attempt to concentrate the naval forces of Brest, Cartagena, and the Texel. It was then that the red flag appeared for the first time on board a man of war, and also, I well believe, what are now called "soviets."

The British sailors named in each ship twelve members of the crew which had charge of the interior discipline of the ship, and two delegates per ship, who, meeting on board the *Sandwich,* under the chairmanship of the famous Richard Parker, a common sailor, ordered the movements of the fleet. Blood was shed, and yet England was at war with France! Finally, by measures of justice and benevolence toward these erring men, and also by rigorous measures against the leaders and the incapable among the officers, all returned to their duty.

The sailors claimed an increase of pay, a bigger and better planned ration, a more equitable division of the proceeds of prizes, more advantages for the wounded, and leave to visit their families on returning from sea. All this was granted, but Parker was condemned to death and executed; several cruises, better chosen and properly conducted restored order and discipline in the crews. The rebellion had lasted three months.—*La Vie Maritime et Fluviale,* 6/25.

GERMANY

THE END OF THE GERMAN NAVY.—The dramatic end of the German Navy at Scapa Flow is an event in history which has much greater significance than the vanishing of the mushroom menace created in less than two decades by one of the most wrong-headed men the world has ever known. In the first place it stamps the nation which has just signed the peace as one which

is neither honorable nor chivalrous, nor appreciating in the smallest degree the true spirit of sportsmanship. In the second place this incident brings out in greater prominence the gross miscalculations made by Germany when she attempted to wrest the trident from British hands. The Germans built their navy under conditions which gave them all that mechanical science could afford, they used it with absolute unscrupulousness, and were protected so far as their own territory was concerned by impregnability, and yet they did not produce a result which was commensurate with the cost involved or the personnel absorbed from the nation. They overlooked the fact that we were an island nation, and being dependent on the sea for our very existence, we had acquired by long experience a sea sense which could not be artificially produced by other people, particularly a purely military nation, under different conditions. When faced with the serious problem of defending the Empire, what did our mariners do? They patiently and earnestly laid down to their job and exercised their inherited faculties and sea spirit against overwhelming odds in the first instance, until their dogged perseverance and fruitful resource brought home to their enemies the rugged truth, that do what they could it was impossible to overcome the pluck and initiative of the British mariner, whether he belonged to the navy, the mercantile marine, or the fishing industry. The criticism which has been passed on the Admiralty as to the opportunities available for scuttling the German Fleet rests on very flimsy grounds, as we fail to see what could be done to exercise surveillance over ships that we could not guard with our own men, particularly as the preparation for the simultaneous sinking of a number of ships could be carried out without any evidence of such preparation being made. The only thing which we think might have been done would have been to move the vessels into shallower water if any idea existed as to an intention to scuttle them. We have always thought from the first that the most satisfactory course was the one originally suggested to sink them in a formal way in the Atlantic. The value and utility of the ships were very small to any country to whom they might have been allotted for the reason that a war vessel is always built around the armament, and therefore these vessels, if used in the manner suggested, must have been re-equipped with new armament and navigating instruments of entirely different types to those originally employed, and consequently the cost involved was not commensurate with the end achieved. Further that when so refitted they would have been quite obsolete. The sinking of the ships by Admiral von Reuter compares very unfavorably as a naval incident with the conduct of Admiral Count von Spee in the Falklands Islands battle, which stood out as a fine example of courage and chivalry.—*The Marine Engineer,* July, 1919.

THE KRUPP GUN FACTORIES.—The *Kolnische Volkszeitung* states that the firm of Friedrich Krupp has fitted out its former gun carriage workshops for the construction of locomotives and railway cars. This firm has guaranteed the Prussian State a yearly delivery of over one thousand locomotives and over two thousand freight cars.

GERMAN LONG RANGE GUNS USED IN BOMBARDING PARIS.—The *Military Technical Review,* completing an article which appeared in a former issue gives some interesting particulars regarding the so-called long distance guns which bombarded Paris.

The article is part of an interview with Professor Rausenberger who invented those renowned guns. Although Professor Rausenberger was not willing to say much, the writer of the article is in a position to state that about eight heavy guns bombarded Paris. They were 21 and 23 cm. guns.

The 23 cm. guns were old 21 cm. guns which had been bored out. They always fired with a constant elevation of 50 degrees. The 21 cm. gun attained a range of 130 kilometers.

Their range could be changed in modifying the charge; moreover, this was also done to spare the guns as much as possible.

The French claim that three such guns were destroyed by their artillery and flying machines. That is not true for none of them have ever been hit by the enemy. One of them could no longer be used, as a shell exploded in the bore of the gun.

Generally speaking, it may be said that the French artillery which fired at the long distance guns, was very well directed from the beginning, for many German gunners were killed when the French fired for the third time. Although the French fired several hundred times with heavy guns, the German long distance guns were never hit. When the Germans withdrew, all of their long distance guns were removed to safety.

There were three groups of long distance guns, one being located near Crepey, about 119 kilometers from the central point of Paris, one south of Gugny and one west of Frere-en-Tardenois. The Germans advanced their long distance guns as soon as the strategic situation permitted them to do so. They also advanced their long distance guns in order to use them much longer, by reducing the charges.

Professor Rausenberger claims that on the ground of his experiences with the 21 and 22 cm. guns he will undoubtedly be able to construct guns of a larger caliber (30 cm.) having a range of 150 kilometers. Everything had already been prepared to construct such guns, with which it would have been possible to bombard both the mouth of the Thames and London from Cap-gris-Nez, near Calais, without being hindered from sea.—*The Military Technical Review,* June, 1919.

HOW GERMANY'S PRE-WAR TONNAGE IS BEING APPORTIONED.—In one of the May issues of the *Hamburger Nachrichten,* Rear-Admiral Hollweg, of the German Navy, discusses the future status of Germany's merchant fleet, which at the beginning of the war amounted to about 5.5 million registered tons. In the spring of 1914, the German Empire possessed no less than 1121 steamers and 136 sailing ships of more than 1000 gross tons. On January 1, 1914, 80,000 sailors were employed in the German merchant fleet.

Through capture and seizure in enemy ports at the beginning of the war, about one million gross tons of German shipping was lost immediately. Another 325,000 tons were captured on the open sea, including 125,000 tons which were forced to leave the asylum of the Suez-Canal only to become an easy prey of the English cruisers. About 2.5 million tons took refuge in neutral ports. Whenever neutral countries joined the Entente the ships lying in their harbors became liable to seizure. In this way 620,000 tons were taken over by the United States; Portugal and her colonies seized 230,000 tons; Italy acquired 170,000 tons, Brazil 239,000 tons, China 21,000 tons, Peru 43,000 tons, Uruguay 42,000 tons, Siam 18,000 tons, Cuba 16,000 tons. With the collapse of Germany's allies, another portion of her merchant fleet fell into enemy hands, viz., 80,000 tons which had sought refuge in ports of the Black Sea and in Austrian harbors.

As a compensation for losses suffered through submarine warfare, 22,000 tons of merchant shipping were turned over to Spain and 38,000 tons to Holland. Chile and Argentina took over 60,000 tons during the war for their own use and without prejudice to the property rights of German shipowners.

Tonnage Surrendered to Allies.—Originally the Allies by an agreement signed at Brussels obtained the surrender of all German merchant steamers in excess of 4000 tons. Of such steamers there were 177 of 1,414,000 tons in home ports. Forty-three of these were passenger steamers with an aggregate tonnage of 424,000 tons. The number of German steamers of

4000 tons and upwards interned in neutral ports is shown in the following table:

Country	No.	Tons
Spain	15	108,123
Canaries	16	104,314
Dutch Indies	25	224,763
Colombia	3	14,116
Mexico, Eastern Coast	1	5,544
Mexico, Western Coast	9	44,099
Danish West Indies	1	5,544
Norway	2	18,000
Argentina	10	71,083
Chile	45	274,211
Holland	20	149,907
Sweden	8	49,113
Russia	3	13,790
	158	1,082,607

Forty-two of these of 151,200 tons were passenger steamers. The vessels lying in Chilean and Argentine ports have had their machinery damaged and are not immediately available for service.

Later on the Allies insisted upon the surrender of all ships of more than 1600 tons and less than 4000 gross tons, whose aggregate tonnage amounted to 504,700 tons. This brought up the total of German shipping demanded by the victorious powers to three million tons. Upon the earnest pleas of the German shipping delegates, however, they were allowed to retain temporarily vessels of 158,975 tons subdivided as follows:

Class	Gross tons
All German Tankers	77,225
Ordinary Steamers	78,214
One Cable Steamer	3,536
Total	158,975

As a result of this concession, ships of a total tonnage of 2,842,000 have only to be surrendered to the Allies.

Recapitulation of Losses.—The losses incurred by the German merchant marine can therefore be recapitulated as follows:

	Tons
Lost at the outbreak of the war through capture and seizure	1,000,000
Lost during the war through further seizures by new belligerents	1,417,000
Lost through the collapse of Germany's allies	80,000
Surrendered as compensation for losses through submarine warfare (Spain and Holland)	60,000
Taken over for temporary use (by Chile and Argentina)	60,000
Surrendered or to be surrendered to Allies	2,842,000
Total	5,459,000

This figure corresponds almost exactly to the total tonnage of Germany's merchant fleet at the outbreak of the war. What tonnage is left in German hands is equivalent to the tonnage of the vessel construction in German yards during the war period. The amount of this is uncertain, but will probably not exceed 600,000 tons.

Whether Germany will be able to recover any of her vessels captured in enemy ports is extremely doubtful. According to the terms of the armis-

tice, Germany had to surrender the vessels captured by her during the war and condemned as prizes in her courts. In complying with this provision, Germany reserved the right to make a similar claim regarding captured German vessels.

Under the terms of the Declaration of London and of the Hague treaty, German ships which were lying in enemy harbors at the outbreak of the war or which entered such harbors after the declaration of war ignorant of the existence of hostilities were to remain German. Not all the nations, however, participating in the war had ratified these declarations of international law. As there was a clause in these treaties requiring all those participating to assent to them before they could become effective, the stipulations in question are not legally binding. The chances of Germany recovering any part of her surrendered tonnage are therefore not good.—*The Nautical Gazette, 7/19.*

GERMAN SHIPPING.—German shipowners have become most despondent since the signing of the Peace Treaty. The freeing of the large European rivers and opening of the German ports to the ships of the Allies without discriminatory charges blocks the way for the resumption of previous German commercial practices. All nations can now trade on the Rhine and other rivers, besides there will now be freedom in trans-shipment at German ports. The stapelrecht, Schifferzunfte, umschlagrecht and similar ordinances will not serve to enable German shipowners to control the commerce of Central Europe as they formerly did. They cannot again be used for purposes of discrimination and preferential rating.

Germans who realize what Germany has lost through the neutralization of the international waterways and the freeing of German ports declare that the Peace Treaty has sounded the death knell of Germany's mercantile marine. All her foreign transportation agencies and shipping businesses have gone to other nations.—*Shipping, 7/19.*

GREAT BRITAIN

NAVAL RIVALRY DEPRECATED.—In its leading editorial a recent issue of the *Naval and Military Record* speaking of the future development of the British Navy said: "The German fleet has disappeared . . . . and the only foreign power which has augmented its navy upon a large scale is the United States. In these circumstances it will not be easy to hit upon a working formula to represent our minimum needs. . . . . We might, of course, base our future building programmes on the corresponding efforts made by the United States, but the objection to such a course is that it would imply a rivalry in armament between the very Powers on whom the world relies to prevent fresh wars. Few people in this country would approve of a naval policy which could in any sense be interpreted as a threat to our friends across the Atlantic."—*Scientific American, 8/2.*

ROYAL AUSTRALIAN NAVY.—The court-martial has been held into the conduct of the seamen and stokers of the *Australia,* who were charged with mutiny without violence at Fremantle early this month. It was stated in evidence that when the ship was preparing to leave Fremantle 100 men gathered on the quarter-deck in "liberty" clothes, and requested that the ship should remain another day in order that they might entertain friends. The request was refused, but when the order was given to let go, the engine-room telegraphed that the stoke-room watch had left the boiler room. Evidence was given that the accused men were of impressionable temperaments and were not bad characters. They were given sentences varying from two years' hard labor followed by dismissal from the service to 12 months' imprisonment.—*Army and Navy Gazette, 6/28.*

SALVAGE NINETEEN SCAPA FLOW SHIPS; BRITISH TO HOLD NO INQUIRY.—One battleship, three light cruisers, and fifteen destroyers of the former German Grand Fleet, which were scuttled by their crews at Scapa Flow, in the Orkney Islands, on June 22, are ready to be salvaged, it was announced to-day in the House of Commons by Walter Hume Long, First Lord of the Admiralty.

Mr. Long said that the work was proceeding on three other destroyers. He said that there was no intention of holding a court of inquiry.—*New York Times, 7/31.*

"U" BOAT PIRATES.—The Admiralty have submitted to the committee dealing with the violation of war usages the names of 71 German naval officers who are charged with the inception and practice of sea outrages or callous conduct. The protocol of the Treaty provides that the names of alleged offenders whose delivery for trial is demanded must be supplied by the German Government within a given time. The offences alleged include the bombardment of non-military ports of the East Coast, submarine acts of exceptional callousness and brutality, the inception and conduct of submarine warfare generally, matters relative to the laying of mines under certain conditions, and other offences. Some of those named are actually in British custody. Every one of the accused is assured of a full and fair trial.—*Army and Navy Gazette, 7/12.*

SUBMARINES.—What the *Sunday Chronicle* calls a new submarine warning is contributed to its columns by Admiral Sir Percy Scott. Submarines, he declares, have come to stay. The war has shown that they may be our greatest danger, and we must lose no time in making preparations against them. It is well to have this obvious truth pressed home. Sir Percy Scott points out that in many respects his prophecies about submarines made two months before the war began—when he was considered by many people to be a dreamer and scaremonger—came true. He evidently agrees with Sir David Beatty that it is a thousand to one against Jutland being the last great sea battle, and thinks it useless to put faith in the League of Nations unless in peace we are prepared for war. Against the submarines of the future he suggests that our line of preparation is indicated by the success of the appliances and schemes which we put into use against the U-boats towards the end of the war. There seems to be an idea that the elaborate and successful anti-submarine organization at the Admiralty, because it was a product of the war, should now be demobilized, but if we are to be safeguarded against future possibilities it would be an entire mistake to do anything of the kind.—*Army and Navy Gazette, 7/12.*

TRIED TO SINK THE "GOEBEN."—Constantinople newspapers received here report that Turkish officers recently made an attempt to sink the former German cruiser *Goeben* at Ismid, Asia Minor, but were frustrated by British officers.—*New York Times, 8/11.*

JAPAN

TWO MORE BATTLE CRUISERS TO BE BUILT.—To complete the plans for the 8:6 squadron, the Minister of the Navy has proposed to our 39th Imperial Diet, appropriations for the construction of two (2) more battle-cruisers.

These new battle-cruisers will be substituted for the present battle-cruisers, *Kongo* and *Hei*, which will enter the second term of ship-age during the Taisho, 11th year (1922).

It has been decided to name the two new battle-cruisers *Akagi* and *Amagi* (each to be of 40,000 tons displacement). One will be built at Kure and one at Yokosuka.—*Yorozo*, a Japanese newspaper, 7/4.

THE DELAY IN BUILDING SHIPS FOR THE JAPANESE NAVY.—For the purpose of accomplishing the plans of our 8:8 fleet before the decided year, our Imperial Navy is now at work building ships at various places, as listed below:

Battleships:
- *Nagato* at Kure.
- *Mutsu* at Yokosuka.

Second-Class Cruisers:
- *Tenryu* at Yokosuka Naval Station.
- *Tatsuta* at Sasebo Naval Station.
- *Harima* at Sasebo Naval Station.
- *Tama* at Mitsubishi Co.
- *Kitagami* at Sasebo Naval Station.
- *Oi* at Kawasaki (Private Co. Kobe).
- *Kiso* at Mitsubishi Co.

First-Class Torpedo Boat Destroyers:
- *Ohikaze* at Maizuru Naval Station.
- *Shimakaze* at Maizuru Naval Station.
- *Nadakaze* at Maizuru Naval Station.
- *Yakaze* at Mitsubishi Co.
- *Hakaze* at Mitsubishi Co.

Second-Class Torpedo Boat Destroyers:
- *Momi* at Yokosuka Naval Station.
- *Kaya* at Yokosuka Naval Station.
- *Nire* at Kure Naval Station.
- *Kuri* at Kure Naval Station.
- *Nashi* at Kawasaki Dockyard (Private Co. Kobe).
- *Take* at Kawasaki Dockyard (Private Co. Kobe).
- *Kaki* at Uraga Dockyard.
- *Toga* at Ishikawajima (Private Yard, Tokyo).

Some submarines, torpedo boats, and other ships for special duty are to be built.

On account of the scarcity of materials and workmen during the war, and the high market price of materials the building of ships has been delayed greatly. But together with the end of the war, having on hand a surplus of labor and materials over industrial requirements there will be no hindrance for the construction of cruisers and smaller warships.—*Tokyo Nichinichi,* a Japanese newspaper, June, 1919.

CONSTRUCTION OF ANTI-AIRCRAFT GUNS BY JAPANESE NAVY.—Reflecting upon the rapid development of aeroplanes in all nations, our Imperial Navy has been conducting an investigation at Kure Arsenal to perfect anti-aircraft guns, especially for the purpose of defence against aeroplane attack. After designing the most complete and effective high-angle guns, at present our navy is making a large quantity of them rapidly, to install on war vessels from big warships down to submarines. Furthermore, if the expense is not restricted our navy has a plan to place them on the tops of high mountains which surround our naval ports, and secondary naval ports, to make complete defence against aeroplane attack.—*Asahi,* a Japanese newspaper, 7/4.

NEW JAPANESE BATTLESHIP LAUNCHED.—The launching ceremony of the *Nagato* (30,000 tons) the largest battleship in the world, which is now under construction at the Kure Dock Yard, will take place this coming November. The ship is now being equipped. Most of her equipment may be accomplished before she is launched. Heretofore the time required for installing the equipment was one year and four months. The *Nagato* will be fully equipped within the short time of five or six months after launching. This will break the record.—*Mancho,* a Japanese newspaper, 24/6.

NAMES OF NEW JAPANESE TORPEDO BOAT DESTROYERS.—The torpedo boat destroyers which will be constructed during the Taisho 8th year (1919) were given names as follows:

Shiokaze, first class torepdo boat destroyer.
Akikaze, first class torpedo boat destroyer.
Yukaze, first class torpedo boat destroyer.
Tachikaze, first class torpedo boat destroyer.
Hokaze, first class torpedo boat destroyer.
Kiku, second class torpedo boat destroyer.
Aoi, second class torpedo boat destroyer.
Hagi, second class torpedo boat destroyer.
Susuki, second class torpedo boat destroyer.
Fuji, second class torpedo boat destroyer.

—*Jiji,* a Japanese newspaper, 5/29.

THE JAPANESE NAVY IS TO EXPERIMENT WITH ELECTRIC DRIVE.—As was expected, the Imperial Navy Department will set about to investigate concretely, sooner or later, electric drive for our warships. The Shibaura factory is now studying the manufacture of two or three kinds of electric-driven propellers of about 300-horsepower each.

Some time during the spring of next year the electric drive will be installed in special duty ships of 200 or 300 tons for the purpose of practical investigation.

Admiral Kato, Minister for the navy, and Vice Admiral Tochinai, Vice Minister, are most earnest for the investigation.

Probably during the 43d Diet, the estimated cost of the investigations will be laid before Parliament.—*Tokyo Nichinichi,* a Japanese newspaper, 6/6.

UNITED STATES

OUR NEW BATTLESHIPS.—Battleship No. 53 for the United States Navy, to be named the *Massachusetts,* the contract for construction of which was awarded recently, will have a length of 684 feet over all, which is an increase of 60 feet over ships of the *Idaho, New Mexico* and *Mississippi* class, the largest now afloat in the U. S. Navy. Its extreme beam will be 106 feet, as compared with 97 feet 4½ inches, the beam of the *Idaho.* In displacement there is a decided increase. The specifications require a displacement of 43,200 tons, as compared with the *Idaho's* 32,000 tons displacement. Instead of specifying a certain degree of horsepower, the contractors are required to guarantee a speed of 23 knots, which is in itself a decided increase over the 21 knots that the ships now in operation are able to develop.

The *Massachusetts* will be an oil burner, equipped with the new electric turbo-generator drive. Its battery will consist of 12 16-inch guns, mounted in two double-tiered turrets; 16 6-inch guns, four 3-inch anti-aircraft guns, and a number of smaller guns for use on boats and for landing parties. In addition there will be two 21-inch submerged torpedo tubes. Its crew will consist of 1,129 men and 62 officers. There will be additional accommodations for 160 men in case it ever seems desirable to increase the complement of the ship.

The *Massachusetts,* as well as her sister ship, No. 54, to be named the *Iowa,* will have the same large cruising radius that characterizes all recent American battleships. Their armament protection and under-water protection against torpedo attack will be unusually complete and will include features which the experience of the war has shown to be of the most vital importance. They will also be equipped with a high-power radio. There will be a reception and reading room for the crew; the men's quarters will be heated and ventilated by a system of warmed forced air. Complete hospital accommodations and dental offices are provided. Showers with hot and

NAVY DEPARTMENT—BUREAU OF CONSTRUCTION AND REPAIR

VESSELS UNDER CONSTRUCTION, UNITED STATES NAVY—DEGREE OF COMPLETION, AS REPORTED JULY 31, 1919

Type, number and name	Contractor	Per cent of completion			
		Aug. 1, 1919		July 1, 1919	
		Total	On ship	Total	On ship
Battleships					
43 Tennessee	New York Navy Yard	82.1	77.6	79.1	74.6
44 California	Mare Island Navy Yard	68.4	60.3	65.6	56.6
45 Colorado	New York S. B. Co	28.4	7.4	26.8	5.6
46 Maryland	Newport News S. B. & D. D. Co.	51.3	42.2	49.7	39.9
47 Washington	New York S. B. Co	28.	6.8	26.2	5.3
48 West Virginia	Newport News S. B. & D. D. Co.	24.2	2.2	23.4	2.2
49 South Dakota	New York Navy Yard	0.	0.	0.	0.
50 Indiana	New York Navy Yard	0.	0.	0.	0.
51 Montana	Mare Island Navy Yard	0.	0.	0.	0.
52 North Carolina	Norfolk Navy Yard	0.	0.	0.	0.
53 Iowa	Newport News S. B. & D. D. Co.	0.	0.	....	....
54 Massachusetts	Fore River S. B. Co	0.	0.	....	....
Battle Cruisers					
1 Lexington	Fore River S. B. Co	Plans	being	revis	ed
2 Constellation	Newport News S. B. & D. D. Co.	Plans	being	revis	ed
3 Saratoga	New York S. B. Co	Plans	being	revis	ed
4 Ranger	Newport News S. B. & D. D. Co.	Plans	being	revis	ed
5 Constitution	Phila. Navy Yard	Plans	being	revis	ed
6	Phila. Navy Yard	Plans	being	revis	ed
Scout Cruisers					
4	Todd D. D. & Const. Co	29.7	7.8	28.2	6.1
5	Todd D. D. & Const. Co	27.3	6.	26.4	4.9
6	Todd D. D. & Const. Co	22.1	1.3	21.7	1.2
7	Beth. S. B. Co. (Fore River)	0.	0.	0.	0.
8	Beth. S. B. Co. (Fore River)	0.	0.	0.	0.
9	Wm. Cramp & Sons Co	14.	....	12.	....
10	Wm. Cramp & Sons Co	14.	....	12.	....
11	Wm. Cramp & Sons Co	3.	....	2.	....
12	Wm. Cramp & Sons Co	3.	....	2.	....
13	Wm. Cramp & Sons Co	3.	....	2.	....
Miscellaneous[1]					
Fuel Ship No. 16, Brazos	Boston Navy Yard	98.5	98.4	97.	96.5
Fuel Ship No. 17, Neches	Boston Navy Yard	26.	14.	25.	10.
Fuel Ship No. 18, Pecos	Boston Navy Yard	.2	.2	.2	.2
Gunboat No. 21 Asheville	Charleston Navy Yard	90.5	85.5	88.1	83.1
Gunboat No. 22	Charleston Navy Yard	5.	4.	4.	3.
Hospital Ship No. 1, Relief	Phila. Navy Yard	43.3	36.9	37.1	29.4
Amm. Ship No. 1, Pyro	Puget Sound Navy Yard	93.	88.	92.	86.
Amm. Ship No. 2, Nitro	Puget Sound Navy Yard	57.	41.	52.	36.
Rep. Ship No. 1, Medusa	Puget Sound Navy Yard	0.	0.	....	....
Destroyer Tender No. 3, Dobbin.	Phila. Navy Yard	0.	0.	....	....

[1] Miscellaneous vessels authorized but not under construction or contract (3):
- 1 submarine tender No. 3.
- 1 destroyer tender No. 4.
- 1 transport No. 2.

There are 154 destroyers, 62 submarines, 7 mine sweepers, 18 sea-going tugs, 19 harbor tugs, 12 oil tankers and 37 Ford eagles in various stages of completion. 12 destroyers, 3 submarines, two mine sweepers, 7 ocean-going tugs and 8 Ford eagles were completed and delivered to the Navy Department during the month of July.

There are 12 additional destroyers and 10 submarines authorized but not under construction or contract.

cold water appliances, a barber shop, laundry and complete commissary department are included. The *Massachusetts* and the *Iowa* will be completed in about 42 months from the time of laying their keels, which will soon be done.

The Bureau of Construction and Repair is now studying the airplane and seaplane situation with the purpose of determining what modifications of battleship construction will be necessary to meet the needs of the new ships from air attack, and before these ships are completed the results of the investigation which Rear Admiral David W. Taylor and his associates are conducting will be available and the superstructure of the ships designed to conform to the needs of naval aviation.—*Army and Navy Journal, 26/7.*

NAVAL POLICY

SHALL THE SUBMARINE BE OUTLAWED?—In the deliberations at Paris and elsewhere since the armistice was signed there have been specific propositions toward a general limitation of armaments, and these propositions lean rather strongly toward outlawing the use and possession of submarines. The arguments pro and con have been fully considered by the experts of the U. S. Navy and we are indebted to Capt. Thomas C. Hart, U. S. N., of the office of the Chief of Operations, Navy Department, who has studied the situation from every angle, for the following estimate of the situation:

"The danger of a repetition of the German submarines' inhuman warfare on commerce by some nation that the future may develop into similar irresponsibility and ruthlessness. This is the strongest argument of the abolitionists and is easily appreciated by everyone. Their opponents, while condemning the inhumanity of the German submarine warfare to the utmost, do not think that these past horrors should be a determining factor. They also point out the enormous effect on the war occasioned by the German submarine campaign, as compared with the actual cost of life. It is generally granted that the Germans failed in their plan to win the war by submarines only because they could not bring them into service in sufficient numbers; at their best, the average number of Germans actually fighting at sea in submarines was about 1000 officers and men and there were literally hundreds of thousands opposed to them; the number of men in Allied vessels engaged continuously and exclusively in strictly antisubmarine work outnumbered the German submarine personnel many fold. Exact statistics are not yet available, but estimates of the actual cost in lives of the German 'unrestricted' warfare are between 10,000 and 15,000—the best figures give about 12,000. Many single day's operations on land cost more lives than that and with infinitesimal results as compared with the effect of the submarines.

"Those not in concurrence with the abolitionists think that the factor of possible mercilessness of submarine warfare should not be separated from the possibly worse horrors of gas, bombing from the air and mines. As for the latter, the parallel seems closest. Only the absolutely ruthless submarine compares with the automatic mine which knows no difference between the bottoms of battleships, hospital ships and passenger ships filled with women and children. That due attention must be given this point is shown by actual loss returns; the losses of British merchant ships, during the war, was by—

Submarines	5,739,000 tons
Mines	6,377,000 tons

The Germans, of course, were mostly restricted to mining from their submarines alone, but once the mine is planted the character of the vessel that did it means nothing. In the last year or so of the war the Allies' defensive measures against mines were largely annulling their effect; but the possibility of future mine inventions that will change this desirable situation is too likely to permit leaving them out of the argument.

"A second argument given emphatically in favor of abolition is that submarines when restricted to their legitimate use of torpedoing the men-of-war of their enemy are not effective—as shown by the small losses of Allied surface warships caused by them in the last war. Those favoring retention point out the fact—as shown by captured instructions—that the objective given German submarines—after there was a sizable force of them—was merchant tonnage, because they estimated the results to be thus attained would soonest win the war for them. It is pointed out that, with the exception of the abortive attempt of last November for which their submarines *only* went to sea, the Germans never planned to have a fleet action and that during the encounters that did occur only casual German submarines participated. Submarine advocates therefore argue that the war furnished no data in the way of results on which conclusions should be based. However, it appears that of the 134 surface warships which the British Navy lost during the war by enemy action sixty-two were sunk by torpedoes from German submarines.

"The argument is made that despite all hydrophone and kindred inventions of a long period during which the best inventive talent of several nations worked under high pressure the submarine is still the only long-radius vessel which, singly and unsupported, can go well nigh anywhere and that, entirely discounting its main purposes of torpedoing enemy warships, as a matter of coast defense, in fleet action or otherwise, its unique defensive quality makes it a naval weapon of utmost usefulness; at the worst, it is never a liability that has to be supported and protected. That the big ship still rules the ocean seems to be generally accepted. How long it will endure is the question. The war has brought no basic advancement to big ships, only a continuance of increase in size, speed and also expense, which for single units has become tremendous. No one can begin to guess what advance the next decade or two will see in other weapons, now properly classed as auxiliary. But this much seems clear: If there can be evolved no limitation in character or size of naval armament, any nation which holds blindly to one line and fails to note development along others will be in ultimate danger from some other nation which does.

"At first the practicability of abolishing submarines seemed high, for the reason that it is purely a war machine only, has no place in commerce or sport and would be difficult to conceal if possessed in readiness for war. There is of late, however, more doubt as to this practicability on the part of those who are keenest to outlaw them and evidences of fear of failure to enforce the prohibition and consequent comparative detriment of our national defence. While the leaders of those nations having the strongest navies have shown a disposition to agree to general abolition of submarines, and destruction of those built, it has gone no farther than that; other nations state that, having weaker navies, the submarine is most important to them, support the arguments for retention and even frankly state that they cannot concur.

"As with most other questions of the day, national altruism seems scarce, their own best national interest determines what is proposed and the pro and con arguments, as briefly and incompletely given above, must be taken, when published, as being intended to persuade to his way of thinking other than the writer's own nationals. It is still to be hoped that there may be evolved from this world situation something in the way of direct armament limitation—both quantitative and qualitative and including in the latter perhaps total prohibition of gas, mine, bomb-dropping and submarine warfare. Unless thus included with other restrictions there seems no chance whatsoever of outlawing submarines. They are therefore likely to be found in all navies in increasing numbers; the prospective increase in capability and war value is only bounded by the enthusiasm of the prognosticating individual."—*Army and Navy Journal*, 8/9.

THE AMERICAN FLEET.—The reported decision of the United States Navy Department to constitute two fleets of approximately equal strength for duty in the Atlantic and Pacific is the natural outcome of the great increase in battleship strength since the existing scheme of distribution was formulated. Owing to the fact that the Panama Canal is in their hands, the Americans have the means to reinforce either fleet very quickly, and thus an objection which might be raised against the division of strength on strategical grounds cannot have the same force as it would have done before the canal was available. Incidentally it may be noted that Great Britain has decided upon a united squadron for duty on both sides, instead of one for North American waters and one for the Pacific Coast, which implies that our ships will be allowed to use the canal as freely as those of the United States. On the other hand, it is always open to us to reinforce our ships on the Pacific Station, as we did in the war, by vessels from the China Seas and from Australasia. Now that the United States have made the Hawaiian Islands a first-class naval base, and a half-way house to the Philippines, it is natural that they should station a much stronger fleet in the Pacific.—*Army and Navy Gazette*, 6/28.

THE U. S. PACIFIC FLEET.—The U. S. Pacific fleet, under Admiral Hugh Rodman, in its passage through the Panama Canal demonstrated fully the strategic value of the waterway by passing from the Atlantic into the Pacific with the greatest ease. The large battleships were passed through the locks almost as easily as canal boats. The entire fleet steamed into Colon early on the morning of July 25 and took on coal and oil. The fleet passed through the canal on July 26, and the average time from Colon to Balboa was ten hours, minus the time spent at anchor in Gatun Lake. The flagship *New Mexico* was the first ship of the fleet to pass through the canal. She was raised out of the three locks of Gatun Dam in one hour and fifteen minutes, and this brought her and the remainder of the fleet eighty-five feet above the sea level. The *New Mexico* was lowered in the two locks at Miraflores in fifty-five minutes, the depth being fifty-five feet to the lake.

The fleet arrived off San Diego August 6 with the exception of the battleship *Rhode Island*, the flagship of Squadron 1, and the battleship *North Carolina*. The *Rhode Island* broke her starboard shaft when she was about 675 miles west of Balboa, and the *North Carolina* took her in tow to return to Balboa. It is reported to the Navy Department that the after compartment of the shaft alley of the *Rhode Island* was flooded, but there were no casualties. On August 2 some of the vessels were reported to have been severely tossed by an earthquake shock, or tidal wave, but the shocks were not recorded by the seismograph at Georgetown University.—*Army and Naval Journal*, 8/9.

MATÉRIEL

A BATTLESHIP COSTS $32,000,000.—The Navy Department estimates that the two super-dreadnoughts for which bids were recently received, will cost with armor and guns a total amount of $32,000,000. These are ships of the 1916 program, and they show an increase in construction cost during the war of nearly 100 per cent. The increase has been progressive, with a big jump, of course, during the past five years. Thus the *Alabama* (11,565 tons) of 1900 cost $2,722,000; the *Connecticut* (16,000 tons) of 1906 cost $4,096,000; the *Florida* (21,825 tons) of 1911 cost $6,400,000; and the *Nevada* (27,500 tons) built in 1915, cost $11,000,000.—*Scientific American*, 2/8.

NEW PACIFIC FLEET NUMBERS 175 SHIPS.—Approximately 175 ships, with an aggregate tonnage of more than 500,000, constitute the newly-organized Pacific fleet. At full strength the armada will be manned by about 34,000

men and 1800 commissioned officers, but the personnel was about 30 per cent below this strength when the fleet began its history-making voyage from Hampton Roads.

Included in the fleet are eight dreadnoughts, six pre-dreadnoughts, eleven cruisers, 108 destroyers of new flush-deck type and 14 submarines.—*N. Y. Times, 7/17.*

PERSONNEL

PERSONNEL SITUATION IN THE NAVY.—At the Navy Department there is no attempt to minimize the fact that the personnel situation is extremely critical at present. In fact commanding officers are urged to give the widest publicity to the gravity of the situation and to take every possible means to stimulate recruiting. When demobilization has been completed about October 1 there will be approximately 72,000 enlisted men in the regular navy, which at present is insufficient to man the fleets alone, with no provision for shore stations, training stations and other duties. As a consequence many ships are being placed in ordinary or taken out of commission. The Naval Appropriation Act provides that the temporary authorized strength from July 1 to September 30 be 241,000; from October 1 to December 31, 191,000; from January 1, 1920, to June 30, 170,000. This means that 100,000 men must be recruited by October 1 next. The navy is attacking its big task with a will and to bring the navy before the public the Bureau of Navigation has been authorized to spend approximately $300,000 for a nation-wide campaign for aiding navy publicity and recruiting.—*Army and Navy Journal, 8/2.*

NAVY REGISTER FOR JANUARY 1, 1919.—The *United States Navy Register* for January 1, 1919, which has just been issued is the largest register ever prepared by the Navy Department. It contains 1283 pages, giving the names of commissioned and warrant officers of the Regular Navy, the United States Naval Reserve Force and the Marine Corps. Rear Admiral James M. Helm is the senior in his grade on the active list, his rank dating from September 14, 1911. In the Regular Navy on January 1, 1919, there were 71 rear admirals, 241 captains, 414 commanders, 788 lieutenant commanders, 1828 lieutenants, 1169 lieutenants, junior grade, 1186 ensigns, all of the line. There were 54 medical directors, 93 medical inspectors, 70 surgeons, 90 passed assistant surgeons, and 966 assistant surgeons. In the Dental Corps there were 29 passed assistant dental surgeons and 95 assistant dental surgeons. There were 30 pay directors, 54 pay inspectors, 68 paymasters, 41 passed assistant paymasters, 598 assistant paymasters; there were 26 chaplains and 141 acting chaplains. Among other officers of the Staff Corps there were 61 naval constructors, 227 assistant naval constructors, 30 civil engineers, 64 assistant civil engineers, all of the Regular Navy. The senior officer in the Fleet Naval Reserve, Class 1, is Lieut. Commander Harry H. Caldwell, and the senior officer in the Naval Reserve, Class 2, is Commodore Robert P. Forshew.—*Army and Navy Journal, 7/26.*

NAVY HAS DEMOBILIZED 316,554 ENLISTED MEN.—Demobilization of the navy is progressing satisfactorily, according to a Navy Department announcement to-day. A total of 316,554 enlisted men have been discharged since the armistice was signed, of whom 94,306 were enlisted in the regular service and 222,248 were members of the reserve force who were released to inactive duty, subject to call. More than 22,500 reserve officers have been returned to civil life, and 7124 are still on duty.

There still are 7000 enlisted men of the reserve force on duty, most of them aboard transports. They will be released as rapidly as recruits can be obtained to take their places. It is expected all of the reserve officers and men remaining in the service will be released within two months.

Recruiting now is more encouraging, the rate of new enlistments being about 5000 monthly. Both the Atlantic and Pacific fleets are still short-

handed, however. Naval officers expect the arrival of the Pacific fleet on the west coast to result in stimulating recruiting throughout the West.—*N. Y. Times*, 7/24.

NORTH SEA MINE SWEEPERS BUSY.—Mine sweepers of the British Navy and the United States Navy are now engaged in making a final sweep of the North Sea. The work is being shared equally between the two fleets, and the "All clear" may be expected some time about the end of November. But this signal will, of course, apply only to the removal of moored mines, and not to a few illusive "strays."

There are over 400 British mine sweepers in the North Sea at the present time, and their business is to gather up what are left of the war. British moored mines still exist off the Belgian, Danish, Dutch, German and Norwegian coasts. The British mine sweepers service is composed entirely of volunteers, and consists of some 600 officers and 14,000 men.

The United States mine sweepers are stationed up by the Orkneys. The Americans laid the large mine field belt which practically stretched from the Orkneys to the coast of Norway, and the removal of this lengthy chain of death now falls to their share.—*Shipping*, 7/19.

MERCHANT MARINE

GIGANTIC NEW LINERS.—Two gigantic ocean liners, larger than any now afloat and designed to cross the Atlantic in four days are to be built by the Shipping Board. Each will be 1000 feet long, of thirty knots speed and will be equipped for use as a commerce destroyer in the event of war. Plans for the ships have been completed, and work on them will be started in the near future. It is proposed to provide a special terminal for them at Fort Pond Bay, L. I., and it may be that two similar liners will be constructed later.

The ships, which are to be built under the supervision of the Navy Department, will be 50 feet longer than the famous *Leviathan*, now the largest ship afloat, and will have a gross tonnage of 55,000. Their draft will be 35 feet, depth 74 feet, beam 102 feet, and accommodations will be provided for 1000 saloon passengers, 800 second cabin passengers, and 1200 steerage passengers.

The crew will number 1000 officers and men, and the ships will be of the oil-burning type with a cruising radius of 7000 miles, which will enable them to complete a round trip on the Atlantic without loading fuel overseas. They will be driven by four propellers and have engines of 110,000 horsepower.

In order that the vessels may be converted into commerce destroyers in time of war, gun emplacements will be built on the decks and the afterdeck will be constructed with a view of transforming it into a landing space for sea planes.

Construction of a terminal at Fort Pond Bay, Montauk Point will represent a large outlay, but the Board's announcement said a great natural depth harbor was provided there, and that in addition the location would reduce the voyage to Plymouth, England by 118 miles, the distance being 2,878 miles as compared with 2,996 miles from New York City. The plans provide for double tracking the present railroad from Montauk Point to New York so as to care for the passengers and freight handled by the new liners.—*Shipping*, 2/8.

OUR SHIP LAUNCHINGS AND DELIVERIES MARK REAL PROGRESS.—Statistics compiled at the beginning of this week by the United States Shipping Board show that 118 vessels, total tonnage 578,583 deadweight, were delivered by American shipyards to the United States Shipping Board in the month of June last. These figures show an increase of 106 per cent over

the figures of deliveries made in June, 1918, when the total tonnage delivered to the United States Shipping Board was 280,400 deadweight.

SUMMARY OF DELIVERIES FOR JUNE, 1919

		D. W. T.	Gross
Contract steel ships	63	361,458	243,652
Requisitioned steel ships	7	52,825	35,217
Wood ships	47	160,800	107,200
Composite ships	1	3,500	2,333
	118	578,583	388,402

Total number of ships reported accepted by the United States Shipping Board from August, 1917, to June 30, 1919, is 1104 with a total tonnage 5,826,664 d.w. or 3,884,443 gross.

Approximately twice as much seagoing tonnage was delivered to the Board in June, 1919, as was delivered in the United States during the year 1916. In that year, which marked the record of pre-war production, 38 seagoing vessels of over 1500 deadweight tons (1000 gross), totaling 285,555 deadweight tons (190,370 gross) were built in this country.

During June, 1919, deliveries made to the United States Shipping Board exceeded by two the entire number of seagoing vessels of 1500 deadweight tonnage (1000 gross tons) delivered in the United States in the 48 pre-war months from 1913 to 1916 inclusive.

June deliveries include 109 seagoing vessels each of not less than 3500 deadweight tons (2,333 gross), and nine tug boats; tonnage not given.

LAUNCHINGS FOR JUNE, 1919

		D. W. T.	Gross
Contract steel	61	391,850	262,635
Requisitioned steel	4	28,750	18,167
Wood	32	76,100	50,728
Concrete	1	7,500	5,000
Total for month	98	504,200	336,530

JUNE, 1918, LAUNCHINGS

		D. W. T.	Gross
Composite	1	3,500	2,333
Contract steel	13	74,300	49,533
Requisitioned steel	13	77,050	51,367
Wood	22	78,700	52,467
	49	233,450	155,633

It will be noted that the launchings for last month show an increase over the same month last year of 40 ships. It will also be seen that many of these ships are of the larger type. The increase in tonnage launched as compared with June, 1918, amounts to 270,750 deadweight tons or 180,897 gross tons. This is an increase of 111 per cent tonnage over the same month last year.—*Shipping*, 7/19.

SIXTY-TWO TRADE ROUTES BEING OPERATED BY THE SHIPPING BOARD.—The United States Shipping Board now has 829 ships, of 4,248,873 deadweight tons, engaged in the general commerce of the seas, exclusive of more than 2,500,000 tons still in war service for the army and navy and in overseas civilian food relief work.

The board has established and now has under operation 62 regular general cargo liner services in trade routes which have been opened in the last

six months as one of the first steps in the conversion of ocean tonnage released from war work to the pursuits of peace.

There are 174 steamships of 1,365,305 deadweight tons employed in the trade routes which have been given regular cargo liner service. The remainder of the commerce fleet is engaged in general cargo and tramp service.

Additional trade routes will be opened and more ships utilized as other tonnage becomes available through release from war and food relief work and deliveries of new ships.

Regular cargo liner services now in operation from the United States reach every quarter of the globe, and there is not a port of entry in the world that is not served better from this country by these regular liner services than by any other means of overseas transport. They give the further advantage in many cases of offering several ports of departure, affording the shipper the choice of North and South Atlantic, Gulf and Pacific ports, which may mean a shorter rail haul and a consequent reduction in the cost of getting his goods to foreign markets.—*United States Bulletin*, 7/28.

FREE AMERICAN PORTS.—A strong movement is afoot for the development of free commercial zones in New York, New Orleans, San Francisco, and other American shipping centers. Our merchants who are endeavoring to retain the foreign trade they were able to secure during the war are finding that a high tariff, high transportation, manufacturing, labor, commodity prices, taxes, and other expenses, the long delays, numerous transshipments of freight for export and other routine demands which exporters have to meet, all seriously affect American foreign trade. They, consequently, believe that free ports should be established at convenient places on the Atlantic and Pacific seaboards, where foreign commerce might be developed without the influences of the many restraining hands now clasping it.

A free port is an old-established institution. There are many of them in operation to-day. Hongkong, Singapore, Colombo, Valetta, Genoa, Gibraltar, Trieste, Cadiz, Hamburg, Bremen, Stettin, Danzig, and Copenhagen are well developed free-ports. All of them, except those of Germany, are at present extremely prosperous.

A free port is, as the name clearly implies, a trading and manufacturing center adjoining territory where trade is restricted by tariffs and other high charges. It is a location where good facilities are offered for the rapid, frictionless discharging and loading of ships, and for the cheap storing, marketing, manufacturing, grading, blending, manipulation and re-exportation of goods. Such zones are essential wherever high port charges, customs duties, fines and fiscal regulations prevent the normal course of commerce running smoothly.

Countries where protection is practiced cannot develop emporiums for handling the world's commercial products. In order, therefore, to enable New York or any other American city to share in the world's trade, a free-trade island, or zone, must be established somewhere within the harbor limits and efficiently equipped with the most up-to-date docking and freight handling plants. It must be an extensive area, furnished with everything necessary for a first-class port.

In such a zone goods might be stored for long periods at very low rates. They could be graded, blended, manufactured and re-exported at remarkably low costs. Ships could be loaded and unloaded expeditiously and without port charges. Among other advantages, a free zone would:

1. Relieve congestion in other parts of the port.
2. Increase shipping and trade.
3. Avoid bonding and draw-back charges and delays.

4. Give owners control over their goods at all times and enable them to work them up into all forms and grade and pack them for export with the minimum of expense.

5. Release nearly two-thirds the capital now required for financing foreign trade.

6. Greatly reduce freight handling, insurance, storing and transportation charges.

7. Assist America in meeting her commercial competitors in the world's markets on a more equal basis.

8. Develop better port facilities and equipment than any now existing.

The establishment of free ports in America is a pressing necessity. In recent years a great change has been made in the character of our internal commerce. We are now a manufacturing as well as a producing country. Our exports of manufactured goods are as valuable as our exports of foodstuffs. If we desire to forge ahead and develop foreign trade and a sound mercantile marine, while preserving protection, we must have free ports. Otherwise circumstances will profoundly change our commercial tendencies.—*Shipping, 7/12.*

NAVIGATION AND RADIO

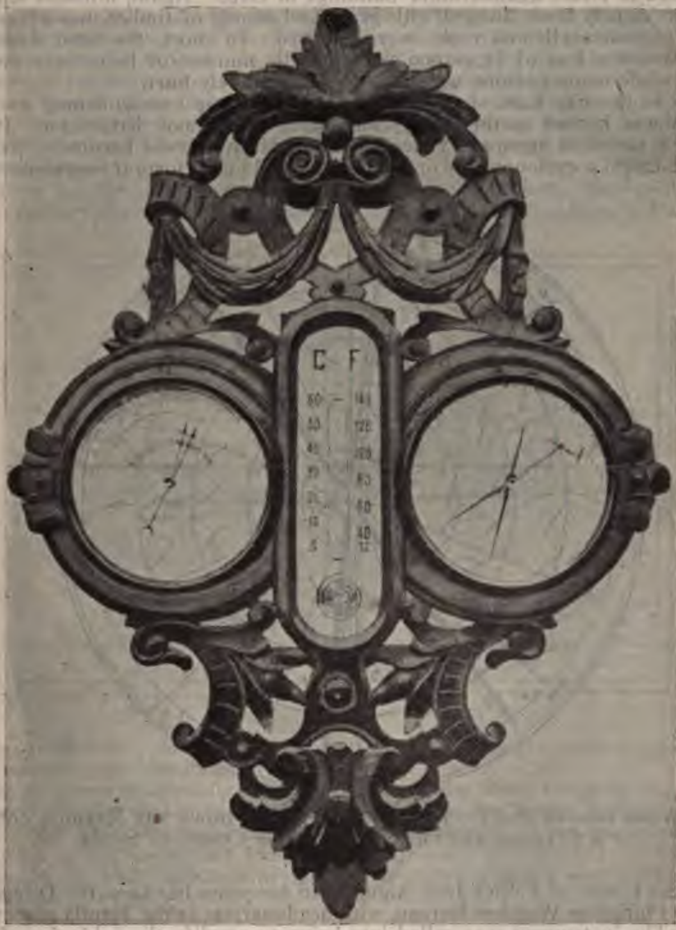
THE ALGUÉ BAROCYCLONOMETER A SENTINEL AGAINST THE UNEXPECTED COMING OF THE HURRICANE.—That the "East is West" has many a pertinent application, and this is peculiarly the case in the matter of dealing with those tempests that are born somewhere on the bosom of the sea and spend their awful might progressively over far-flung areas.

Out in the Orient they have the typhoon, while in this hemisphere we have its smaller kin, the hurricane of the West Indian waters and the neighboring regions of the North Atlantic. Both are types of cyclonic storms; and it is because of the violent nature of their rotary winds that devastation so frequently marks their paths. Certain instrumental means developed to forewarn of an advancing typhoon have to-day notable value in helping us to predict the approach of a hurricane and to take steps which may minimize its ravages.

Most of us know by repute, if not by actual experience, just how destructive a hurricane can be at times; and not infrequently the loss of life or the injury to property is due to the lack of precautionary measures. That is to say, the ship at sea unwittingly heads right into the tempest when it could just as easily steer away from the storm center; again, the craft at anchor in an exposed harbor, inviting disaster, could avoid certain ruin by bravely taking to the open sea; and, finally, lives are imperiled by waiting too long before seeking places of security.

Reasons are multiplying that make it all the more of vital concern to us that we should have advance knowledge of the whereabouts of a distant hurricane and be able to follow its course and foretell just where it is likely to cross the lanes of shipping, touch our insular possessions, or strike our southern shores. Month by month, the volume of water-borne traffic threading the Caribbean Sea, the Gulf of Mexico or the Atlantic Ocean contiguous to the West Indies, is going to increase as peace re-establishes and amplifies our foreign trade. Similarly, the coasts of Florida and the littoral of other Southern states are drawing to them added dwellers and stimulating industries, aside from luring the yachtsman and many other pleasure-seekers. And, further, we have assumed additional responsibilities in the way of warning of impending hurricanes by our purchase of the Virgin Isles. Recognizing this, the United States Weather Bureau is establishing at Fort Myers, Florida, a special station for the purpose of detecting and predicting the approach of hurricanes. Before the authorities are through, we shall probably have a series of these meteorological outposts scattered throughout our West Indian holdings, and why this should be done can be realized if we cite merely a single instance of the havoc wrought in large part through a lack of advance knowledge of the oncoming tempest.

On the evening of October 9, 1916, the Virgin Islands were swept by the most destructive hurricane that has occurred in that area since 1867. The hurricane broke upon them with little warning. Only a short while before the storm arrived hurricane signals were hoisted and the customary guns

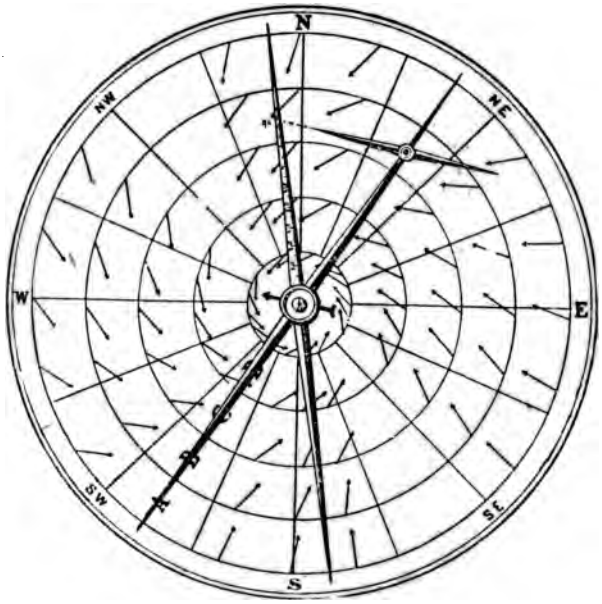


A. BAROCYCLONOMETER. THE WIND DISC IS ON THE RIGHT AND THE BAROMETER ON THE LEFT OF THE THERMOMETER, WHICH GIVES READINGS OF TEMPERATURE, BOTH BY CENTIGRADE AND FAHRENHEIT.

fired to spread the news abroad beyond the visible range of the bunting. These signals, unfortunately, did not suffice to arouse the populace to prompt action—they were too late; and well-nigh before storm shutters could be adjusted on homes, and other buildings, the skies let loose their torrential rain and angry gusts of wind—the forerunners of the body of the hurricane—swept the islands. The blast rapidly grew in intensity until the wind attained a maximum velocity of about 125 miles an hour. Vessels

were driven ashore and wrecked. The Danish cruiser *Valkyrien,* however, just managed to ride out the blow in safety, thanks to her two bow anchors which were out, and to her engines, which were kept running at full speed. In some instances houses were torn bodily from their foundations and smashed to pieces against other buildings or trees. Again, hillsides which had previously been covered with grass and stands of timber, were blasted bare so that earth and rocks were exposed. In short, the total damage represented a loss of $1,500,000 and a goodly number of lives were sacrificed, while many persons were more or less gravely hurt.

Out in the Far East, since 1901, there has been in ever-widening use an instrument known as the barocyclonometer or typhoon barometer. It is really a two-fold apparatus: a combination of an aneroid barometer and a device called a cyclonometer or wind disc. In its final form it represents the



THE WIND DISC OF THE CYCLONOMETER WHICH SHOWS THE VARIOUS ZONES OF A CYCLONE AND THE WAY THE AIR CURRENTS SWIRL.

climactic labors of Father José Algué, who for years has been the Director of the Philippine Weather Bureau, with headquarters at the Manila observatory. The instrument was called into being to amplify the field of usefulness of the ordinary aneroid barometer, and next, to supply information which the barometer cannot give—information essential to locating the whereabouts of the cyclonic storm center and then to following its onward sweep. His primary object in developing this ingenious apparatus was to save life and property as far as possible, and likewise to dissipate to a measurable degree that terrifying alarm which used to grip the inhabitants of the Philippines when the cyclone season was upon them.

Until about the beginning of the eighties, typhoons swept from their unknown places of birth in the Pacific down upon the hapless peoples of the Philippines, causing grave sacrifices, many of which might have been avoided or lessened had the natives been sufficiently forewarned. This has all been changed by the aid of the barocyclonometer, simply because that

instrument had made it possible to forecast the coming of the typhoon when that tempest is a full 500 miles away. Not only that; through it the observer can determine the probable regions over which the storm will vent the worst of its fury.

The typhoon, just like the hurricane, moves forward more or less deliberately, its approach being heralded by natural phenomena, sometimes days before it actually arrives. It is the rotary intensity of the storm's body, increasing towards the vortex which does the greatest harm. Therefore one can readily grasp how important it is to foretell not only the coming of the cyclone, but the line of travel of its dreaded center. Father Algué has used for the foundation of his barocyclonometer the previous work of two fellow priests.

Nature has her own good way of divulging her intentions. Our problem is to read her signals aright. Years ago at the Havana Observatory, Father

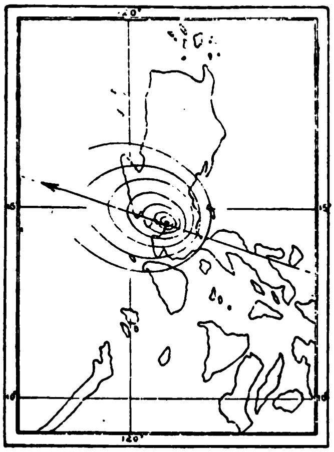


FIG. 1

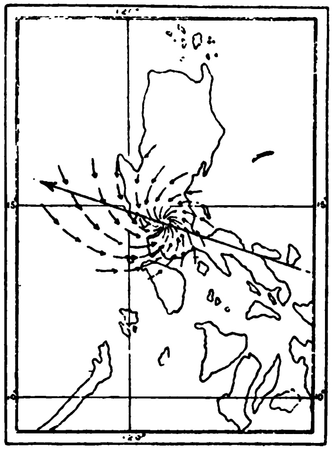


FIG. 2

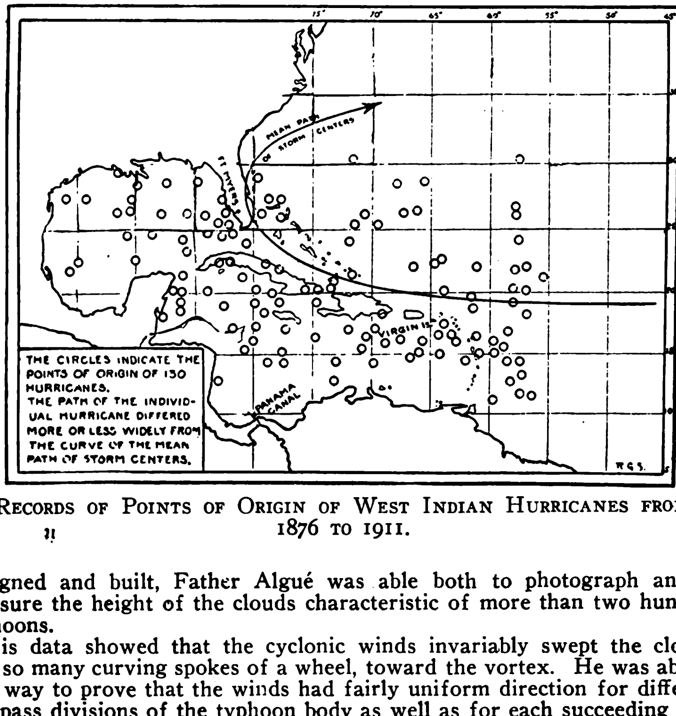
Fig. 1 illustrates the zones of barometric pressure taken while a typhoon was passing near Manila.

Fig. 2 shows graphically the way in which the wind swept at the distances from the center of the same storm. The big arrow, in each case, marks the general line of advance of the typhoon. Thus the pressure recorded by the barometer indicates the different zones, while the winds mark the compass direction of the storm center which a navigator does his utmost to avoid.

Benito Vinés sought to find in the heavens some premonitory signs of the gathering hurricane, with which he was distressingly familiar. He found that high in the sky, days before the storm broke, certain cirro-stratus clouds of a comet-like form which hung persistently aloft day and night, invariably preceded a tropical tempest of a cyclonic character. These feathery clouds dipped toward a common spot upon the horizon, and repeated observations proved that they pointed towards the vortex or center of the atmospheric disturbance. They were the outermost swirls of the rotary winds—the cyclone area covering a possible diameter of a thousand miles. Father Vinés's studies furnished the groundwork for a further series of meteorological investigations by Father Algué, and these in turn led to the invention of the wind disc of his barocyclonometer.

The barometer, as most of us know, is sensitive to differences of atmospheric pressure; and an area of high pressure commonly means fair weather, while a low pressure region is just as often the provocation for foul weather. This is because we have a depression, so to speak, in the atmosphere toward which the outlying "high" rushes to fill and to re-establish uniformity. This movement gives us the winds, which we call storms or tempests, according to their violence; and the more abrupt the changes of barometric readings within relatively short distances the greater the velocity of the atmospheric movement, *i. e.*, the wind.

While the barometer will give warning of threatening weather when the center of the disturbance is hundreds of miles away, still the instrument has no sense of direction—it will not tell where the cyclone is lurking. Here is where the preliminary studies of storm clouds by Father Vinés served to guide Father Algué. By the use of special instruments, which he



RECORDS OF POINTS OF ORIGIN OF WEST INDIAN HURRICANES FROM 1876 TO 1911.

designed and built, Father Algué was able both to photograph and to measure the height of the clouds characteristic of more than two hundred typhoons.

His data showed that the cyclonic winds invariably swept the clouds, like so many curving spokes of a wheel, toward the vortex. He was able in this way to prove that the winds had fairly uniform direction for different compass divisions of the typhoon body as well as for each succeeding zone of the storm—working from the center of the tempest outward to its uttermost rim. These winds varied with the season of the year, and in themselves indicated whether the observer were to the north, south, east, or west of the dreaded mælstrom.

This sounds simple, but it took a vast deal of patient research and the reducing to "means" of meteorological records covering many years to get the germ of the problem. It was upon these averages so painstakingly established that the practical application of Father Algué's discoveries was based.

Strange as it may seem, particularly in the tropics and semi-tropic areas, the normal daily and nightly oscillations of the barometer vary with

remarkable regularity, and because of this rhythm any decided change is a positive evidence of meteorological disturbance in the nature of a storm.

Father Algué's predecessor at the Manila Observatory had devised a type of barometer which did give warning of the proximity of typhoons, but it was distinctly local in its value and misleading when relied upon beyond the Philippines. His problem was to design an instrument which would be of helpful service in any part of the Eastern seas; and to achieve this it was necessary that the apparatus be adjustable so that it might be set to suit a particular area. Father Algué's aneroid barometer has, in effect, a double face or dial consisting of an inner fixed disc and an outer revolvable flat ring upon which are engraved the different weather sectors and arcs denoting the nearness or remoteness of the storm center. This ring can be swung to correspond with the seasonal and local conditions which should prevail normally in fair weather at the point in question. Any variations of the barometer from these local standards, therefore, are sure indices of atmospheric turbulence thereabouts.

For convenience's sake, the cyclone sector of the dial ring is divided into A, B, C, and D areas—representing distance—which show how far away the storm is. These zones, surrounding the center of the tempest, have been carefully determined by an exhaustive analysis of meteorological records covering years of observations. Thus, by means of his wind disc and his adjustable barometer, the priestly scientist has furnished both the mariner and the man on shore a storm-warning apparatus of great value. Seven years ago, at the instance of the Navy Department, Father Algué visited Havana and then came to this country, where he made a close study of the weather records, and afterwards adapted the barocyclonometer for use in the North Atlantic and the approaches to the eastern end of the Panama Canal. It is this modified form of his wind disc and barometer which is henceforth to stand guard against the unexpected coming of the West Indian hurricane.—*Rudder,* August, 1919.

HYDROPHONES AND THEIR USES.—At the recent hydrographic conference at Liverpool, the employment of hydrophones was urged as a means of lessening the danger of navigating the high seas. It has long been known that sound waves travel through water four times as fast as in air, but this knowledge could not be put to any practical use on account of the impossibility of determining by the human ear either the source or the direction of sound waves traversing a water medium. Two years ago, however, Lieutenant Georges Walser, of the French Navy, perfected an instrument for picking up sound waves out of a body of water and transmitting them to a listener stationed on a vessel. Briefly described, the new device consists of an acoustic lens fixed on the side of a vessel in the bulging surface of which there are a number of round holes ranged in a circle and each filled with a sensitive vibrating plate or sound focal point. When the sound waves strike this lens, they are deflected, strengthened and isolated from other sounds. The listener on shipboard is equipped with a listening helmet to which are attached two ear trumpets, which can be revolved past the focal points above mentioned. By taking the focal point at which the sound is heard loudest and clearest through the trumpet, the direction from which the sound waves originate and their distance can then be calculated with the help of an ingeniously arranged scale placed alongside of the edge of the drum whose handle must be turned in order to revolve the ear trumpets. Thanks to this device, U-boats at a distance of fifteen miles could be accurately located and overtaken during the war. At the present time, the hydrophone is being successfully used for sound ranging in the North Sea in connection with the removal of the mines planted while the war lasted. As it would reveal the approach and exact location of machinery propelled craft bound in their direction, merchant vessels equipped with this recent invention would run very little risk of

collision even in the thickest fogs. By catching the sounds emitted by a bell buoy, those in charge of a ship out of its course could gauge its distance from shore thereby avoiding the risk of running aground. Considerable time may elapse before the hydrophone is generally adopted by merchant men, but once it is universally installed, ocean navigation in obscure weather will be robbed of many of its present perils.—*The Nautical Gazette*, 8/9.

TRISECTION OF AN ANGLE.—An exceedingly simple construction for the trisection of an angle is as follows:

$B\ A\ C$—Fig. 1—is the given angle. At any point D in $A\ B$ draw $D\ E$ parallel to $A\ C$. With centre D and radius $D\ A$ describe the circle $A\ F$. Choose any line passing through A and cutting the circle and $D\ E$ in points F and E, such that $E\ F = A\ D$. Then $\angle E\ A\ C$ equals one-third of $B\ A\ C$.

PROOF. $A\ D = D\ F = F\ E$ by construction. $\therefore \angle D\ A\ F = \angle D\ F\ A$ and $\angle F\ D\ E = \angle D\ E\ F = \angle E\ A\ C$. $\therefore D\ E$ is parallel to $A\ C$. But $\angle D\ F\ A =$

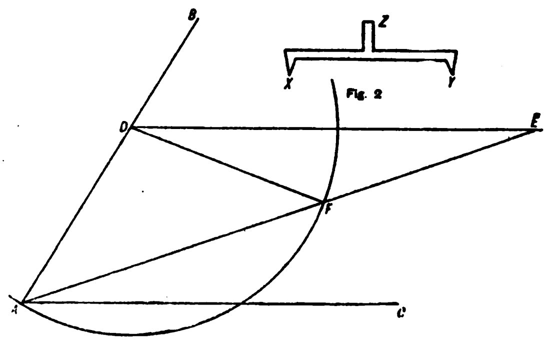


FIG. 1

$\angle F\ D\ E + \angle D\ E\ F =$ twice $\angle D\ E\ F$. Therefore $\angle D\ A\ F =$ twice $\angle E\ A\ C$. $\therefore E\ A$ trisects $B\ A\ C$.

This problem is not strictly Euclidean in that Euclid does not provide for the rotation of a line to such a position that the intercept on two other lines is of a certain length, but as a practical problem it is exceedingly useful.

As an addition to a set of mathematical instruments the gadget shown in Fig. 2 forms a useful adjunct.

The pin Z is arranged to fit into leg of the compass such that the center point of the compass and points X and Y all lie always in the same straight line. The distance $A\ D$ is marked off so as to be equal to the distance between the points $X\ Y$, and the circle center D and radius $A\ D$ is drawn in accordance with the figure. The center point of the compasses is then set to A and the compasses rotated and adjusted until X falls on point F and Y on point E. The straight line $A\ F\ E$ can then be drawn in, and this will trisect the angle.—*Engineer*, 7/4.

RADIO MONOPOLY URGED BY NAVY DEPARTMENT.—Legislation of far-reaching importance in its bearing on radio communications between the United States and the rest of the world is being sought by the government at Washington, as part of the plan for monopolizing transocean and international radio service to and from American shores, as well as between ship and shore.

In identical letters to Vice-President Marshall and to Speaker Gillett of the House, Secretary Daniels asserts that government operation and control of all transocean and ship-to-shore wireless stations used for commercial purposes in this country is "necessary, on account of present interference between stations," and sets forth what the Navy Department regards as other cogent reasons why these important fields of radio telegraphy should be dealt with by the Federal Government as a natural monopoly.

The legislation sought by the Secretary of the Navy seeks legislation along these lines: (1) Study of radio problems within the United States by a special committee or commission; (2) authority for the President to establish bands of wave lengths for transocean and ship-to-shore services; (3) government monopoly of transocean and international radio service; (4) authority for the navy to use immediately all navy radio stations for commercial or press business; (5) authority for the navy and other departments to aid in the development of American-owned radio stations abroad and the use by them of government-owned patents and improvements.—*N. Y. Times*, 7/29.

PACIFIC COAST RADIO STATIONS.—With the completion of a series of radio compass stations now in process of construction by the government, the North Pacific Coast will be in possession of radio facilities of material help to coastwise navigation.

Radio compass stations are now being installed at Tatoosh, Dungeness and a point on the San Juan Islands. In addition to the radio stations being built at the entrance of Puget Sound and on the strait, others are being established on the coastline near the entrance of Grays Harbor and along the Oregon and California coasts.

With the establishment of these compass stations, each of which are located short distances apart, so as to comprise a chain along the entire coastline, a vessel at sea may readily obtain its position in case of heavy fogs or other disturbances. The ship sends a radio which is picked up by the shore compass stations and the position computed and flashed back to the vessel. At twenty-five miles off shore, a ship's position can be deducted within a mile; at five miles off the position is figured within two boat-lengths.—*Shipping*, 8/9.

NORWEGIAN INVENTION OF RADIO TELEGRAPHY DEVICE.—According to *Norges Handels og Sjorfartstidende* of May 6, 1919, Engineer Hermod Petersen has recently patented a device for the production of electrical current for radio telegraphy. The electricity is received by an accumulator, which releases it at certain intervals. The system is sparkless, and the sounds are clearer than in the older inventions. The clearness of sound depends upon the regularity of the current, and with this system the current is released with a mathematical exactness. The device is claimed to be cheaper, simpler, and more durable than those now in use. If the claims made for this invention prove well founded, it is thought that it will mark a distinct step in advance of what has so far been accomplished in this line, and hence its possibilities are creating considerable interest in the radio world.—*Shipping*, 8/2.

RADIO TRANSMISSION FORMULAS FOR ANTENNA AND COIL AERIALS.—The aerial of a radio transmitting or receiving set is either a condenser or an inductance coil of large dimensions. It effects the transfer of power between the radio circuits and the ether. The coil aerial has the inherent advantage of serving as a direction finder and interference preventer, but is less effective quantitatively as a transmitting or receiving device than the condenser aerial commonly called the antenna. The practical question, how far can communication be maintained by a coil in comparison with an antenna, is answered by the following formulas, derived from electromagnetic theory. A flat-top antenna is considered, and a rectangular coil.

Let h = height of antenna or coil, l = horizontal length, and N = number of turns of wire of coil aerial, I = current, λ = wave length, d = distance apart of transmitting and receiving aerials, R = resistance of receiving aerial circuit. The subscripts s and r refer to sending and receiving, respectively. All lengths are in meters.

Antenna to antenna:

$$I_r = \frac{188.\, h_s h_r I_s}{R\lambda d}$$

Antenna to coil:

$$I_r = \frac{1184.\, h_s h_r l_r N_r I_s}{R\lambda^2 d}$$

Coil to antenna:

$$I_r = \frac{1184.\, h_s l_s h_r N_s I_s}{R\lambda^2 d}$$

Coil to coil:

$$I_r = \frac{7450.\, h_s l_s h_r l_r N_s N_r I_s}{R\lambda^3 d}$$

These formulas were derived by J. L. Dellinger, of the Bureau of Standards two years ago and have been found useful in the Signal Corps and navy work since that time. Either the equations as here given or the component equations giving the field produced by a given antenna or coil aerial and the received current produced by a given field, lead to the solution of questions of design which it would be difficult to settle by experiment. Such quantitative experiments as have been made have verified the formulas to 25 per cent or better, some observed values of received current being higher and some lower than the theoretical values.

The actual current received when a coil aerial is used is frequently greater than the formulas indicate, because such an aerial acts both as a coil and as an antenna by virtue of its capacity to ground. This double action of the coil structure is likewise indicated by values obtained for radiation resistance and by the observed directional properties.

The use of the coil aerial is particularly advantageous, as may be seen from the formulas, for short waves. In most cases, the usefulness of the coil increases as its dimensions are made to approach the order of magnitude of the wave length. An advantage of the coil not apparent from the formulas is that its resistance can usually be made lower than that of the corresponding antenna.—*Journal of the Franklin Institute,* July, 1919.

ENGINEERING

ALCOHOL AS MOTOR FUEL.—Increased demands for gasoline with accompanying increase in price have again directed attention to the utilization of substitutes, particularly alcohol, as fuel for internal-combustion motors. The supply of petroleum is limited, and as this limit is approached the price is certain to advance still more, it having doubled during the past six years in this country and more than doubled abroad. On the other hand, the supply of alcohol from vegetable matter is practically inexhaustible, and the sooner it comes into general use for power purposes the longer will the gasoline supply be conserved.

Heretofore the restricted use of alcohol has been due to its inability to compete in price with gasoline, this handicap having been intensified by governmental restrictions. Whether the point has now been reached where successful competition is possible, is a matter for investigation.

The British Government, viewing with concern the rising price of gasoline, last November appointed a committee to inquire into the production and utilization of alcohol as a motor fuel. This committee has recently submitted its report. It found that while alcohol is obtainable from molasses, potatoes, wood pulp and other vegetable products, the yield, contrary to popular opinion, is not large; that from potatoes, for instance, being only twenty gallons per ton. It can also be produced synthetically from coal and coke-oven gas, but the most promising source appears to be from tropical plants of which the sun-dried flowers of the mahua tree will yield ninety gallons per ton.

The usability of alcohol in internal-combustion engines with a properly designed carburetor and slightly modified compression is well recognized, so that there is no obstacle from the engineering standpoint. It is purely a commercial problem. Owing to the somewhat lower heat value of alcohol a correspondingly greater quantity must be used per horsepower-hour, so that in order to compete with gasoline the cost per gallon must be proportionately less.

As a means of keeping down the cost the committee recommends that the British Government modify the restrictions concerning the storage and distribution of alcohol, consistent with the prevention of its improper use—a recommendation that might well be given serious consideration in this country. It reports further that, while not definitely committed to the idea that the time has arrived when alcohol can compete commercially with gasoline, it believes nevertheless that such time is not far distant and strongly urges that steps be taken by the British Government to carry on such investigations and give such support to the alcohol industry as will put it on its feet to meet any further increase in the price of gasoline.

While true that the motor-fuel situation is much more acute in England than in this country, yet would it not be well for this government to profit by the recommendations of the British committee and by a little forethought through investigation avert a possible crisis a few years hence?

Some eight or ten years ago an effort was made to interest the farmer in the utilization of farm refuse for the production of alcohol on a small scale. To this end certain restrictions were removed, as applied to farms only, and the Department of Agriculture issued instruction pamphlets. The response to this effort, however, was small, perhaps owing to the then low price of gasoline and to the fact that the farmer at that time was not a large user of internal-combustion engines. But that condition has changed, the farmers now have their automobiles and are large users of internal-combustion engines to drive the various farming implements. Perhaps a renewal of the former efforts would now bring results.—*Power*, 8/5.

DEVELOPMENT OF THE SEARCHLIGHT.—A review of the work of the Army Engineer Corps in the war, first issued by the War Department, says that the corps produced a new form of searchlight more powerful than any that had preceded it in any army, with which the Second Field Army had been partially equipped. "It weighed," the report says, "one-eighth as much as lamps of former design, cost only one-third as much, was about one-fourth as large in bulk, and threw a light 10 per cent stronger than any other portable projector in existence." Still further to perfect the searchlight, our engineers were at work on a remote control when hostilities ceased.—*Scientific American*, 7/19.

BURNING POWDERED COAL.—With the increasing cost of coal, while at the same time the quality steadily decreases, it becomes of greater and greater importance to find the most efficient methods for combustion. The burning of coal in powdered form is conceded to-day by engineers to be the eventual method for coal combustion, since it offers opportunities for high

efficiency and controlled combustion not offered by any other method of burning.

Few people realize, unless closely in touch with this development, how much has been accomplished during the past five years. Since the early '90's the cement industry has been using powdered coal as its fuel, and to-day it may be said in all truth that the successful and cheap production of cement rests on the firing of rotary kilns with powdered coal as standard practice. In 1912-13-14, the use of powdered coal in firing numerous large reverberatory furnaces used for smelting copper ores was successfully worked out. To-day some of the great copper producers are burning hundreds of tons of powdered coal daily.

The use of powdered coal has reduced fuel consumption to such an extent that to-day some plants are smelting six tons of ore with only one ton of powdered coal. The whole trend of the copper smelting industry has been changed by the use of powdered coal in their enormous furnaces. In the early days powdered coal was injected into the furnace with a stream of high-pressure air. Even when firing in such a crude way as this, the results were such as to make the use of this fuel in the cement industry a much more efficient method of kiln firing than any other method used up to that time.

In developing the use of powdered coal in other fields where smaller furnaces were to be fired and more delicate operations carried on, it became necessary to work out other burning equipment in order to have better control over combustion, to speed up combustion and to get away from the disadvantages of injecting the coal stream with a jet of high-pressure air and the poor mixture obtained by this method. This change to the use of low-pressure air was a change necessary to bring about the widespread application of this fuel as has been seen in the past five years.

Equipment has been developed which is self-contained and easily regulated, and which will burn quantities of coal as low as one ounce per minute. From this extremely small capacity the equipment ranges up to the capacities demanded by the largest industrial furnaces and boilers.—*Engineering World*, 7/15.

New Chisel Steel of Unusual Properties.—An American steel company, making all grades of electric tool steels, announces that it has produced an alloy chisel steel which can be made so hard that it will cut glass yet may be bent by being hammered over the edge of an anvil. This steel, the manufacturer states, has a wide temperature range, as it may be heated anywhere between 1650 and 1950 degrees F., and yet give good results.

The steel seems to have its greatest value when heated to 1750 to 1800 degrees, quenched in oil and slightly drawn. The drawing it is stated, does not seem to affect the hardness of the steel, but it helps the toughness. Many theories can be evolved as to just why this slight drawing is of such assistance to this steel, but metallographically there is no evidence of difference between straight hardening and hardening and drawing. The same structure can be produced as seen under the microscope, yet there is a great deal of difference between the two heat instruments.

A point emphasized is that the head of a chisel made of the new steel will not sliver. It is also stated that the head of the chisel can be heat treated so that it may be filed, yet it will not break out or crack. It will spread, but it will not split, yet the top of the head does not take on a very glassy surface and seems to have a grip on the hammer-face when it is struck.

It is pointed out that metallographically the steel is peculiar. It seems to have a very fine structure, which is difficult to define. It may be a solid solution which is generally regarded as austenite, or it may be martensite. It seems under the microscope to have an appearance at lower magnification of the whole range of solid solution steel, yet it has the characteristics of

none. Under high magnification of 1200 diameters the structure appears to be somewhat like martensite, yet the martensite appears to be lamellar rather than the usual 60 degrees marking.

The grain boundaries, which are particularly tenacious, have the coloring effect of troostite, yet they do not have the usual troostite formation. Troostite does not begin to form in round spots at the grain boundaries in Seminole steel, but seems to have the characteristic of broadening out the grain boundary into a dark line. From this stage the entire grain begins to etch a little more rapidly and take on a darker color, but the ground mass of the grain does not appear to alter in general characteristics as is usually found in the transformation from austenite, martensite, troostite and sorbite, as understood as applying to the usual form of alloy steels or carbon steels.—*Scientific American*, 8/2.

COPPER IN RUSTPROOF STEEL.—In a paper recently read by D. M. Buck before the American Society for Testing Materials, it was brought out that very small amounts of copper have the effect of reducing corrosion in steel. Tests were made of open hearth steel with various copper additions, so that there was from 0.012 to 0.254 per cent of copper in the ingots. These were rolled into sheets and exposed to the atmosphere in the Connellsville coke region, together with a number of pieces in which there was no copper. It was found that a mere trace of copper was sufficient to prevent rapid corrosion.—*Scientific American*, 7/26.

SHIPPING BOARD TO MAKE DIESEL ENGINES.—According to recent dispatches from Washington, the United States Shipping Board has taken over the right to manufacture one of the standard European Diesel engines, and will manufacture them on a vast scale. This is in line with the decision of the Shipping Board made over a year ago to undertake motorship construction. Officials of the Board say that America is compelled to adopt the motorship to meet European competition.

Among the chief reasons for discarding the steamship in favor of the motorship are, according to the Shipping Board: Saving of two-thirds of the oil used as fuel. Saving of more than 25 per cent in wages due to the cutting down of the engine room force and the entire elimination of the fire-room gang. Increase of a vessel's steaming radius from a few thousand miles to not less than 30,000 miles. A contract for the construction of the engines has been let in Pennsylvania and in less than three months one completed Diesel engine will be delivered each day.—*The Nautical Gazette*, 7/19.

INTERESTING APPLICATION OF HEAT.—A recent issue of the *General Electric Review* describes a method of heat shrinking for fitting parts of electrical machines on to their shafts. The method overcomes various difficulties experienced with press fittings. Water or steam heating is used for flywheels and couplings, while for armatures and field systems conveniently situated heating resistances answer the requirements. In one case mentioned, *i. e.*, a large armature, the shaft was 35 inches in diameter. Cold pressing would have required a maximum pressure of 600 tons. By heating the armature to about 80 degrees C., however, the shaft could be pulled on with a five-ton chain hoist.—*Scientific American*, 8/2.

LIBERTY.—A TRADE-MARK REGISTERED BY THE UNITED STATES OF AMERICA.—A certificate of registration of the trade-mark "Liberty" as used on aeroplane engines was granted by the United States Patent Office to the United States of America on June 17, 1919. This is the first instance of the government of the United States registering a trade-mark under its own trade-mark laws, or the laws of any other country, although other governments have registered their marks in the United States Patent Office for the goods on which they are used. The Republic of France has registered

marks used on cigarettes, and several registrations have been granted by the United States Patent Office to the Imperial Government of Japan. Some government activities, such as the War and Navy Department's Commission on Training Camp Activities, have been granted registration of their trade-marks.

Everything connected with the history of the mark "Liberty" as used by the United States on its aeroplane engines is unique. When the Liberty engine was first developed in the summer of 1917 it was referred to by the government engineers as the "United States Standard Aircraft Engine" or the "United States Standard Engine." Some genius, however, selected the right word and all the district offices of the Bureau of Aircraft Production, which was then the Equipment Division of the Signal Corps, were soon notified that the use of the word "Liberty" as applied to the new engine was so popular that it seemed inadvisable to attempt to use any other name. This word was a happy selection.

Trouble resulted in a short time, however, from the great popularity of the word "Liberty" as applied to articles of commerce. Many manufacturers began to designate their goods by the term "Liberty." This use of the term on goods which are of the same general class as engines or on goods adapted to be used on engines resulted in confusion and probably in deception. Government officials soon saw that it was necessary to protect the name. After considering several ways of getting the best protection of the right of the government in the use of the word "Liberty," the plan of registering it in the United States Patent Office under the United States Trade-mark Law was adopted. These proceedings resulted in the grant of certificate of registration No. 125,853, which under Section 16 of the Trade-mark Act constitutes *prima facie* evidence of ownership of the mark "Liberty" as used on engines and parts thereof.—*Aerial Age, 7/27.*

TRANSLATING DRAWINGS FROM METRIC TO ENGLISH MEASUREMENT.—Sometimes it is necessary to translate metric dimension drawings into fractional inch drawings, or *vice versa.* Incidentally different standards for pipes, bolts, threads, etc., are incorporated so that ultimately the two designs are not interchangeable.

If we establish the arbitrary rule that one inch shall equal 24 mm., all sixteenths may be expressed in millimeters and only one decimal place is involved. Now, 4 inches = 101.6 mm., while we made 4 inches = 96 mm.; accordingly the metric version of the designer's pipe-dream has shrunk 4½ per cent. This is generally quite harmless, but is eminently useful as it eliminates a great deal of figuring.

Gears of which the center distances have been translated in the above fashion will work out with metric (module) cutter with very little trouble. Take, for instance, two gears of 4 pitch with 14 and 19 teeth; the first has a pitch diameter of 3½ inches and the latter 4¾ inches and the center distance is 4⅛ inches.

According to our way of calculating 4⅛ inches = 99 mm. To get the module we divide, 2×99, by the sum of the teeth, thus:

$$\frac{2 \times 99}{33} = 6$$

The metric gears will thus figure out to be $6 \times 14 = 84$ mm., and $6 \times 19 = 114$ mm., and the center distance

$$\frac{84 + 114}{2} = 99 \text{ mm.}$$

According to the American Machinists Handbook the table comparing the pitch and module cutters or gears shows that the translated gear is just as strong—for all practical purposes—as the original gear. This example is not specially selected; it was chosen at random, but with

7-pitch gears, results may not be obtained at the first shot. This scheme is also friendly to metric bolt sizes as they increase by 3 mm. To proceed in the reverse direction two rules may be selected from. The first, 25 mm. = 1 inch, gives all even millimeters in two decimals; the design shrinks less than 1 per cent, but involves the use of unwieldy decimals.

The second, 24 mm. = 1 inch, gives all millimeters which are multiples of 1½-inch sixteenths and the design swells about 5 per cent; for instance, 419 mm. is not a multiple of 1.5, the figure nearest to it is 418.5 = 17 7/16 inches and the error introduced if the latter figure is taken is perhaps not sufficient to throw the design out of plumb.

Needless to say, the above method of calculating, which is used by Dr. C. P. Schwartz, in the *American Machinist*, applies best when a design has to be adapted without attempt at interchangeability.—*Engineering and Industrial Management*, 7/10.

CONDENSERS ON TURBINE SHIPS PLYING IN THE TROPICS.—On a turbine-propelled vessel built to run between home and tropical countries it is essential that an ample condensing plant be installed to deal with the high-temperature sea-water of the tropics. Otherwise a considerable falling off in efficiency will take place, with a corresponding reduction in the speed of the vessel.

The adverse effect of high-temperature water on the vacuum in a condenser is very marked. Investigations and experience have shown that if provision be made for home waters only, a drop in vacuum of 1½ inches to 2 inches may be expected in tropical waters. The reduction in economy and power developed with this reduced vacuum is appreciable, and may be taken at a minimum figure of 10 per cent, which would correspond to a reduction in the speed of a vessel of at least 3 per cent, or half a knot in a vessel of 17 knots normal speed.

The maximum temperature of sea-water in the tropics may be taken at 85° to 87° Fahr., and it is impossible under this condition, if the plant be properly designed, to obtain a vacuum of 27½ inches. This entails a considerable increase in condensing surface over that required for home waters only, and may amount to at least 40 per cent of extra surface, with additional pumping capacity of probably half this amount.

The attainment of high vacuum with turbine machinery under all conditions of service is most important and the saving in economy effected by fitting an ample condensing plant will justify the extra cost involved in its manufacture.—*Nautical Gazette*, 7/19.

AERONAUTICS

HELIUM.—Up to the present time all military and most other balloons have been filled with hydrogen. This gas, although giving the greatest lift which it is possible to secure, is so highly inflammable as to make the destruction of balloons by fire, not only in war time, but during operations under ordinary conditions, a serious matter. For example, the writer happens to know personally of twenty-six cases in which kite balloons or dirigibles have been completely destroyed by fire, caused by atmospheric or frictional electricity, during the last two years. Many attempts have been made to minimize this fire hazard by fire-proofing balloon fabrics, and by use of hot air or ammonia in place of hydrogen, but so far without success. The use of helium instead of hydrogen affords absolute safety from fire, whether caused by accidental electric sparks or by incendiary or explosive bullets of an enemy in time of war. An adequate supply of helium will, therefore, entirely revolutionize balloon practices, and will do more than any other one thing to assure to the nation possessing it, that control of the air which will in the future be absolutely necessary for any adequate plan of national defence.

The history of helium is interesting. About 70 years ago, a line was discovered in the spectrum of the sun's atmosphere, which could not be identified as belonging to any element known on the earth. This unknown gas was, therefore, named helium. Many years later, a thimble full of a gas, occurring in very minute quantities in the earth's atmosphere, was isolated by Sir William Ramsay, and proved to be the hitherto unknown element to which the name helium had been given. It was then proved to be not only incombustible, but inert in every other chemical way and to have about twice the density of hydrogen. Still later it appeared that this gas is formed whenever radium or any other radio active material disintegrates and for a time active chief source from which helium was obtained in small quantities for scientific research was certain radio active minerals. Still later helium was found to be a constituent of certain natural gases, particularly those occurring in Southern Kansas, parts of Oklahoma and Northern Texas, and processes were developed at the University of Kansas for purifying it so cheaply that it could be sold to scientists, in small quantities, at something like $1700.00 per cubic foot. At that time the total quantity of reasonably pure helium in the world was probably less than 100 cubic feet. In the face of so discouraging an outlook, some one in the British Admiralty had imagination enough to propose seriously that helium should be produced in sufficient quantities for the British Balloon Service, and experiments were undertaken in Canada for this purpose. A report on this matter was found in a mess of British documents sent to this country soon after we entered the war, by the Gas Warfare Committee of the Bureau of Mines and the matter was brought to the attention of the Signal Corps and the Bureau of Steam Engineering. Since that time about six millions have been either spent or obligated, the entire practicability of the production of helium on a large scale at a cost of ten to fifteen cents per cubic foot has been demonstrated, and production plants to yield 40,000 to 60,000 cubic feet per day are now being constructed or under test.

Three processes, alike in fundamental principles, but differing in important details, are being tried. One of these, the Linde process, has demonstrated its success and is the basis of the production plant now being built. The second, the Claude process, gives promise of a somewhat lower operating cost than the Linde process, but has not yet been entirely perfected. At present this plant is temporarily shut down until the new government pipe-line can provide it with an adequate supply of undiluted Petrolia gas, at which time the final test will be made. The third process, invented by Norton and developed by the Bureau of Mines, is the basis of the large experimental unit in Plant No. 3. This unit is still being worked into shape by Norton, the inventor, and it is hoped that satisfactory results will be forthcoming within the next two months. It gives promise of an operating cost lower than either of the others.

The active supervision of the production program for helium, with the exception of Plant No. 3, has been placed in the hands of the Navy Department by mutual agreement between the army and navy. All that it is necessary for the army to do at the present time is, therefore, first, to keep in touch with the work the navy is doing in behalf of both departments; second, to prepare itself for the proper utilization of the helium that will be supplied to it under the agreement with the navy, and, third, to assume the responsibility of providing an adequate supply of the necessary raw material, in the future.

It is further suggested that there is much to be done before the army will be ready to use this new gas in the most effective way. A small repurification plant has already been authorized and plans for it are nearly completed. The question of modifying the designs of the various types of balloons in use, so as to make them appropriate for helium, should be undertaken at once. The chief difficulty is connected with the very large

waste of gas involved in the methods of handling balloons at present in use. This waste of gas will have to be very largely reduced by careful experimentation and by changes both in balloons and in the manual of tactics before the use of helium in balloons of the army types will be justified from the point of view of the whole problem of national defence.

Finally, it must be remembered that the supply of helium in the United States, although large, is by no means unlimited. At the present time probably a million cubic feet per day is being fed through the natural gas mains of various cities in the Middle West and being dissipated into the atmosphere through thousands of chimneys. Steps should be taken at the earliest possible moment to secure for the army and navy the right to process all supplies of natural gas containing usable quantities of helium before this gas is distributed. The details of such a procedure will require careful study and for this purpose an Argon Conservation Committee consisting of a representative of the navy, a representative of the army and a representative of the Bureau of Mines was appointed last August by the Aircraft Board and an adequate allotment to cover its expenses recommended. For various reasons effective action by this committee has seemed impossible until very recently. It is now hoped that the committee can proceed with its work in the near future.—*Aerial Age*, 8/11.

A ZEPPELIN SECRET REVEALED.—To many people one of the chief minor mysteries of the war centered round the means whereby our authorities were made aware, well in advance, of a projected airship raid against this country. That they were so informed in some manner or other soon became obvious to all, at least in the London area, for it was seen that on the nights upon which raids occurred the searchlights were not practiced at dusk. On one occasion, we can remember, it was confidently asserted that the warning was received of a probable raid almost twelve hours before it actually took place. The mystery has now been solved, and that by one of no less authority than Lord Weir himself. It was quite a simple matter after all; the Germans told us they were coming! Their airships were guided across the North Sea by means of directional wireless on a system involving the sending out of frequent signals from the airships themselves. These signals were picked up by the German wireless stations, which thereupon transmitted to the vessels signals indicating their exact position. Unfortunately for the enemy we also could pick up the signals sent out by the airships, and just as readily as the Germans determine therefrom their position. We thus always knew when they were coming and where they were coming from, and arranged our defences accordingly. Our own directional wireless system, perfected late in the war, avoids this serious military objection to its use. The directional coils are carried by the aircraft, which, picking up signals from home stations, is able to locate its position without telling it to the enemy. It would have been employed, it is confidently believed with success, to guide the two Handley-Page four-engined machines which were ready on November 8 to fly from this country through the clouds to Berlin and back.—*The Engineer*, 7/25.

THE COST OF A BIG AIRSHIP.—In the British House of Commons recently, Dr. MacNamara, replying to Lieut. Commander Kenworthy, said: "The cost of constructing an airship of *R-34* type is approximately £350,000. The cost of the housing shed at East Fortune, together with extensions and wind-screens, is approximately £166,000. Fourteen officers and 400 men are required at the station for handling, berthing, cleaning airships, etc. The estimated total monthly cost of the airship when in commission depends on the distance flown. Taking as basis 8000 nautical miles per month at a speed of 40 knots, it amounts to about £2600 at current rates for cost of petrol, oil, and gas. This figure includes the wages of crew, and also one-fourth the total pay of the personnel required for handling.

etc., as this latter is adequate for maintaining four airships in commission. No further airships of this class are under construction, but six of improved types have been ordered and are in varying stages of construction. Work upon them is being continued.—*Shipping*, 8/9.

PLAN CABINET AIR OFFICER.—Combination of the army, navy, marine corps, and postal air services into one separate department, headed by a Secretary of Aeronautics, who would be a Cabinet officer, is proposed in a bill introduced to-day by Representative Curry of California.

The department would have control of the development of commercial aviation and the issuance of licenses to civilian airmen. The Secretary of Aeronautics would be appointed by the President, confirmed by the Senate, and receive a salary of $12,000.

A feature of the bill is its provision for an aeronautical academy to train fliers. The establishment of aircraft factories is also provided for. The operations division of the department would prepare plans for national defence and mobilization.—*N. Y. Times*, 7/29.

ELECTRICALLY-HEATED CLOTHES FOR AIRMEN.—The extreme cold encountered at the higher altitudes makes it necessary to provide electrically-heated clothes for airmen, at least in the instance of most military machines which offer no protection to the passengers. The energy required to heat these suits is generally around 80 watts, disposed as follows: Helmet, 20 watts; each glove, 16 watts; each moccasin, 14 watts. The energy is supplied at 12 volts, either from a storage battery or from a small fan-driven generator of streamline shape mounted on the airplane, the fan being rotated by the passage of the plane through the air. The heating elements are flat loops of resistance wire spaced about seven per inch and about 9/32 inch wide per row. They are machine-sewed on a cotton cloth base, the cotton thread being carried along the top and bottom of each row of loops parallel to the horizontal axis of the row. Flexibility results from this mounting, and the base can be stretched or crumpled at will without danger of breaking the wire. Each heating element is composed of two bare wires in contact with one another throughout a considerable part of every loop, so that if a break occurs in any one wire, the effect is merely to force the small amount of energy concerned through a conducting path of smaller cross-section between the break and the near points of contact.—*Scientific American*, 8/2.

NAVY AVIATION DIVISION DISCONTINUED.—Admiral William S. Benson, Chief of Naval Operations, issued instructions on July 22 discontinuing the Aviation Division of the Office of Naval Operations and distributing its various activities among the bureaus of the Navy Department. Capt. T. T. Craven, Director of Naval Aviation, under the new arrangement will occupy the position of a liason officer. In his instructions Admiral Benson calls attention to the fact that the plan of the office of Naval Operations embraces the following divisions of work: Planning Division, Matériel Divison, Intelligence Division, Communication Division, Inspection Division, Operating Forces and Files and Records Division. He directs that the Planning Division absorb the Aviation Section, the Submarine and Mining Section, and Gunnery Exercises and Engineering Performances Section, and that the matériel of these sections be handled by the Matériel Division of his office. He also directs that the administration of personnel and training matters be handled by and directly under the Bureau of Navigation, and that the operations of submarines and navy aircraft be administered under the Division of the operating forces of his office.

The discontinuance of the Aviation Division entails the distribution of all activities and follows the navy system of separating the administrative from production and operating requirements. It would seem to be in line with

the purposes of the proponents of an air department, whose strongest argument is that aviation production, design and experimentation should be centralized and that operation should be handled by bureaus in the army, navy, postal service, etc. Admiral Benson's instructions will make the Bureau of Construction and Repair responsible for construction of airplanes and airships, the Bureau of Steam Engineering for the design and production of engines and instruments, and the Bureau of Ordnance responsible for supplying the armament. It will also call for the reassignment of some 18 officers now attached to the Aviation Division.

The action of Admiral Benson will probably result in much discussion as to whether the specialized service of aviation can be made to function and progress under the new arrangement as it has most certainly functioned and progressed as a separate division in the office of Naval Operations. The change will be watched with more than ordinary interest for the reason that the air services as recognized arms of the fighting forces of all nations are just at present under the widest public attention and, too, for the reason that European nations are already abroad introducing their air navigating machines in foreign lands, particularly in South America. The matter of Admiral Benson's instructions is so recent that there has developed little opinion of the desirability of the change among the chiefs of Navy Department Bureaus.—*Army and Navy Journal*, 8/2.

RELIABILITY OF SERVICE BY AIR.— Probably no subject has been so widely written and talked about in recent months as that of civil aviation, the very idea of which had been banished from our minds during the war. Fares and freight-rates, speeds, weights carried, comfort and safety have all had their share of attention from technical or non-technical writers. These questions in reality hang one and all upon reliability. The business man will long since have agreed on the utility and advantages of air transport, but when its reliability comes up for comparison with that of the railway train he shrugs his shoulders. Starts are planned and not carried out "owing to weather" or "engine trouble." Accidents happen. Though commercial flying will, in my opinion, be well supported by the public, there is still a large section which calls for statements on this question, and not without reason.

There are difficulties—serious problems—to combat. The two chief ones are adverse weather and engine failure, in that order because the former is much more serious. We can improve engines but not our climate, though even this is not a serious problem outside of northern latitudes.

Multiplicity of engines on one machine is a factor making for reliability, where the machine is designed to fly on anything above half of its engine power. Advanced as is the modern internal combustion engine it is not perfect, and when two or more are fitted a margin can be relied on in case of failure in one of the number. It requires more power to take a machine off the ground than to maintain it in the air. Every pilot knows this margin of power, with which he can dispense once his wheels have left the grass.

The motorist may ask, "Why all this trouble with aircraft engines when I have run my car 40,000 miles without a single breakdown?" In an aircraft engine it goes without saying that weight is reduced to the last ounce, but it is doubtful if the average motor owner realizes to what figures this has been achieved. The world-famous Rolls-Royce 40—50 h. p. 6-cylinder automobile engine weighs 11 lbs. per h. p. This firm's latest 350 h. p. aeroplane engine approximates 3½ lbs. per h. p.! More important than this reduction of weight is the question of "revs." Ninety per cent of the running on a Rolls-Royce car is done with the engine turning over at about 400 r. p. m. The aeroplane demands four times that rate of revolution: the fact is, it cannot afford to carry an engine weighing more than 3½ lbs per h. p. and that engine must develop practically its last ounce of h. p. the whole time. If on every outing a car engine were run for three or four hours at

1600 r. p. m. it would soon give trouble: how much more, then if it were lightened by 75 per cent in addition to being continuously run at that speed.

Multiplicity of engines, however, will ultimately overcome not engine failure but failure due to engine breakdown. If the modern aircraft power unit possesses a considerable factor of reliability, two units on the same machine double that factor, and so on almost in proportion. The Handley-Page which flew from Ipswich to India was a standard Berlin Bomber—our Atlantic entry is another—fitted with four 350 h. p. Rolls-Royce, totalling 1400 h. p. Much as one may rely on modern engines, on one unit of 1400 h. p. the flight would not have been completed—at any rate without weeks of delay en route. Engine trouble dogged it on many important stages, but these were always completed on the remaining units. If an engine fails it usually fails completely, and the only way to allow for failure is to split up the total power into several independent units. The harshest critic with any knowledge of recent performances in the air could hardly say that more than one out of four average engines to-day will give trouble on a 3/4 hour's flight. Multiplicity of engines will therefore save the situation as far as engine failure is concerned, by eliminating the inconvenience, not to say danger, of involuntary descents en route.

Weather as a flying problem may be divided up into four sections. Wind was once considered an insuperable difficulty. Now nothing short of a hurricane need delay the start of a journey. Rain and snow are unpleasant but not really dangerous. Progress in aerial navigation will soon enable us to fly above clouds, descending only to land at our destination. This has been proved by Zeppelins during the war. January 31, 1916, will be remembered as one of the worst raids on England, yet in parts of Yorkshire then bombed there was a snowstorm raging.

Thunderstorms affect compasses, but they are never accompanied by fog or even clouds connected enough to obscure any considerable area of ground. In daylight they can be surmounted, as they rarely stretch above 9000 feet. They are "local," to use a meterological phrase, and if encountered on a flight they can be avoided if not surmounted. One young pilot known to me describes a patrol during a thunderstorm near Dunkirk as one of his most fascinating flights. He even thinks we ought to run special pleasure trips on those occasions to let people see the glory in those great pillars of thick greasy cloud rising from a murky gloom at 1000 feet to pinnacles of dazling white in the sunshine at 8000.

By night thunderstorms do present a difficulty at present apparently insurmountable. But then they are rare, and perhaps that is why they have not yet been tackled seriously.

The paramount problem of all-weather flying to-day is fog—the airman's last, worst, and most deadly enemy. With it might be classed Scotch mist, which is almost as bad. It is possible in a safe machine of some inherent stability, to leave the ground in fog and rise through the bank, which rarely stretches above 1000 feet. Once above it, so much was learnt of navigation over open sea during the war that there is little difficulty in steering a course by compass and reaching the *neighborhood* of one's destination by dead reckoning. But there our pilot is faced with the real problem—how to locate the actual aerodrome and enter the fog again to perform the delicate operation of landing? Research, experiments, tests are being carried out unremittingly to reach a solution, and all this work will bear fruit. Among the suggestions is one to utilize captive balloons over every aerodrome, well above the fog bank, with perhaps an observer in the car in communication by phone with the ground below. He would signal directions to approaching aircraft, communicating instructions from the aerodrome manager. On the balloon cable would be streamers indicating height, according to a predetermined scale, and wind direction, though fog is not often accompanied by enough breeze to signify. These would give the oncoming pilot an idea of the height of fog above the surface of the aerodrome, for an aneroid set at his starting point cannot be relied on for a place two or

three hundred miles away. Where the balloon cable enters the fog might indicate the approximate position in which a machine of normal glide should make the plunge, while the balloon observer would signal the direction he should take. A weighted wire let down about 20 feet below the level of the machine, and arranged to light a flash lamp in front of the pilot's eye when the weight touches the ground, would tell him the moment to "flatten out." Given a level aerodrome and a machine of really low gliding and landing speed, this idea should prove a success.

For night fog-flying the same idea could be arranged, balloon and cable being strongly illuminated and searchlights brought into use either pointing along the landing ground or vertically at its corners to mark its extent.

The hanging wire connected with a flashlamp was used by seaplane pilots landing on unlit water after night patrols or raids, and proved quite successful.

Absolute reliability and schedule running is not to be expected at first. Did any form of transport make such progress in its early days as aviation has done since 1914? When Bleriot flew the Channel it was regarded as a freak performance, and now the Atlantic flight is being described as such. It is a step—a significant stage in aviation, just as was the first steamship crossing in the thirties.

The fact is, that design and construction of aircraft are ahead of engines and meteorology. "Performance" was our shibboleth during the war—speed, climb, and contortional ability. As a result the qualities that make for reliability and success in civil aviation were left behind to some extent. It is surely the first duty of civil aerial organizers to prove that in these qualities we can gain and keep the same supremacy as we held in the more warlike attributes on November 11, 1918.—*United Service Magazine*, July, 1919.

MISCELLANEOUS

PROPOSED SCIENTIFIC ESTABLISHMENTS FOR THE FUTURE.—With a view to developing and extending the scientific results which were obtained under stress of war, the British Admiralty has recently put forward proposals for the permanent establishment of a Department of Research and Experiment within the navy.

Plans have been formulated for the erection of a Central Research Institution for the investigation of first principles and for carrying on researches of a fundamental and pioneer character. Steps have already been taken to organize a sea experimental station and to provide buildings and equipment for an engineering laboratory, a wireless and signal school, and a torpedo and mining school in place of Vernon.

It is believed that these institutions will prove of great value in developing not only means of increasing the efficiency of the navy, but in providing aids to navigation for our mercantile marine.

The initial expenditure for buildings and equipment will be large, but it seems evident that an ample financial return will in a short time be obtained for the nation from profits accruing from a lowering of the rates of insurance and from a reduction in the cost of transportation. If we could by the use of such aids to navigation as have been referred to above prevent two or three wrecks per year, or lower the time of passage between Great Britain and Canada on the average by one day per voyage per ship through the fog-covered areas in the neighborhood of Newfoundland, sufficient funds would be saved in a year or two to cover the whole cost of the expenditure on scientific and experimental establishments and on the prosecution of the researches and investigations foreshadowed.—*The Engineer*, 7/25.

NAVY SETS NEW RECORD.—Former German liners, converted merchantmen and warships operated by the Cruiser and Transport Force of the Atlantic fleet transported from Europe to the United States during June

a total of 315,067 troops, which is 9000 more than were transported to Europe by all vessels of the allied nations during any one month of the war, it was announced yesterday by Vice Admiral Albert Gleaves. This, it was stated, was in addition to troops carried by other agencies.

To handle these troops 136 ships were employed, all manned by navy officers and crews, included among them being the giant transports *Leviathan, Imperator, Kaiserin Auguste Victoria,* and other large ships taken over from the Central Powers. Leading all others in the handling of troops during June was the *Leviathan,* which has carried on the return voyage since the signing of the armistice a total of 76,422 men.

Some exceptional records in rapid "turn arounds" at Brest have been recorded. The record probably is held, however, by the transport *Great Northern,* which made a round trip in a trifle more than twelve days. Included in this time was the discharging at Brest of 5000 dozen eggs and 7000 tons of fruit and the taking on board for the return trip of 3130 passengers and troops, four lighters of baggage, 350 sacks of mail, 4000 barrels of oil, and 500 tons of sugar. The time spent at anchorage at Brest was five hours and ten minutes.—*N. Y. Times, 7/17.*

MILITARY HISTORY PRIZE.—The American Historical Association offers a prize of $250 for the best unpublished essay in American military history submitted to the Military History Prize Committee before July 1, 1920.

The essay may treat of any event of American military history,—a war, a campaign, a battle; the influence of a diplomatic or political situation upon military operations; an arm of the service; the fortunes of a particular command; a method of warfare historically treated; the career of a distinguished soldier. It should not be highly technical in character for the object of the contest is to extend the interest in American military history; but it must be a positive contribution to historical knowledge and the fruit of original research.

The essay is not expected to be less than ten thousand or more than one hundred thousand words in length.

It should be submitted in typewritten form, unsigned; and should be accompanied by a sealed envelope marked with its title and containing the name and address of the author; and a short biographical sketch.

Maps, diagrams or other illustrative materials accompanying a manuscript should bear the title of the essay.

The Committee, in reaching a decision, will consider not only research, accuracy and originality, but also clearness of expression and literary form. It reserves the right to withhold the award if no essay is submitted attaining the required degree of excellence.

For further information address the Chairman of the Military History Prize Committee, Milledge L. Bonham, Jr., Louisiana State University, Baton Rouge, Louisiana.

CURRENT NAVAL AND PROFESSIONAL PAPERS

The Future of American Shipping. By Edwin N. Hurley. *Universal Engineer,* April, 1919.

Peace—or Truce? 1. The Peace According to Versailles—1919. By George A. B. Dewar. 2. The Peace According to Herr Erzberger—1914. By George Saunders. 3. After the Signature. By Harold F. Wyatt. 4. War and Peace, Limited or Unlimited. By Major R. M. Johnston, U. S. A. *The Nineteenth Century and After,* July, 1919.

The Great Peace. By the Right Hon. Sir Joseph Compton-Rickett, M. P. *The Contemporary Review,* July, 1919.

The Liabilities of the Treaty. By Wm. Harbutt Dawson. *The Fortnightly Review,* July, 1919.

Japan, Yesterday, To-day and To-morrow? By Prof. Joseph H. Longford (late H. M. Consul, Nagasaki). *The Nineteenth Century and After,* July, 1919.

DIPLOMATIC NOTES

FROM JULY 18 TO AUGUST 18

PREPARED BY

ALLAN WESTCOTT, Associate Professor, U. S. Naval Academy.

TREATY RATIFICATION DELAYED

NO APPOINTMENT ON REPARATION COMMISSION.—On July 18, President Wilson wrote to Senator Lodge, Chairman of the Senate Committee on Foreign Relations, requesting approval of the temporary appointment of an American member to the Reparation Commission in Paris, pending ratification of the treaty. On the following day the Senate Committee passed a resolution to the effect that until the treaty was ratified no power existed to make the appointment.

PROPOSED ALTERATIONS OF LEAGUE COVENANT.—Consideration of the Peace Treaty in the Senate and the Senate Committee on Foreign Relations was directed almost entirely to the Covenant for a League of Nations. Objection centered chiefly upon the Shantung settlement, Articles X and XI, guaranteeing the territorial integrity of signatory states, and the clauses relating to withdrawal from the League and control of domestic affairs. Two general methods of conditional ratification were considered: (1) that of inserting "interpretations" giving a precise and acceptable meaning to clauses in dispute, but not requiring the approval of other powers; (2) that, favored by the more radical opponents of the League plan, of inserting reservations or amendments that would require acceptance by other nations.

President Taft, in a letter to the Chairman of the Republican National Committee made public on July 22, offered the following six "interpretations":

1. That upon two years' notice the United States could cease to be a member of the League without having the League pass upon whether she had fulfilled all her obligations under the covenant.
2. That self-governed colonies and dominions could not be represented on the League Council at the same time with the mother government, or be included in any of those clauses where the parties to the dispute are excluded from its settlement.
3. That the functioning of the Council under Article X shall be advisory only, and that each member shall be left free to determine questions of war in its own way, the decision of the United States resting with Congress.
4. That differences between the nations regarding immigration, the tariff, and other domestic questions shall not be left to the League for settlement.
5. That the Monroe Doctrine is to be reserved for administration by the United States.
6. That the United States reserves the right to withdraw unconditionally at the end of ten years, or at least to terminate then her obligations under Article X.

THE LODGE RESERVATIONS.—In a speech before the Senate on Aug. 12, Senator Lodge offered five reservations to be added to the League Covenant, and to have the practical effect of amendments. Senator Lodge suggested that these should be accepted by at least the four other great powers in the Council of the League. The proposals follow:

1. On Article 10, touching upon the guarantee of territorial integrity of nations in the League, so as to provide that Congress retain definitely the right to say when and where American soldiers are to fight. Under this reservation it would be impossible for the League to compel America to send forces into any conflict anywhere without the consent of Congress.

2. On Article 11, relating to the right of the Council to pass upon any emergency of "war or threat of war" and to recommend any action it deems "wise and effectual to safeguard the peace of the world." Under this Lodge reservation proposal any decision of the Council involving the use of American forces would be subject to the consent of Congress, as in the case of Article 10.

3. As to the Monroe Doctrine, stating plainly that it is not to be subject to interpretation or construction by the League Council.

4. On purely domestic questions, such as immigration, the tariff and racial matters, these all being reserved entirely for American determination.

5. On the two years' withdrawal clause, the United States Government, and not the League Council, to determine if America's obligations under the covenant have been fulfilled.—*N. Y. Times,* 13/7.

FRENCH TREATY SUBMITTED TO SENATE.—Complying with a request expressed in a Senate Resolution, President Wilson, on July 29, submitted to the Senate the text of the Proposed Treaty with France, and on August 11 the informal draft of a League of Nations covenant which was prepared by the American Peace Commission. The draft was found to conform closely to the actual Covenant, Article X on territorial integrity being practically identical.

OTHER NATIONS RATIFY PEACE TREATY.—The Peace Treaty, including the League of Nations Covenant and the Anglo-French defensive agreement were passed by the British House of Commons on July 21, and by the House of Lords on July 24. In the course of the debate in the House of Lords, Earl Curzon stated that it had not been finally decided that the trial of the ex-Kaiser would be held in England.

The Peace Treaty was ratified by the Belgian Chamber of Deputies on August 8, and by the Polish Parliament on July 31. Ratification was also recommended by the Peace Treaty Committee of the French Chamber of Deputies by a vote of 34 to 1. According to a Paris dispatch discussion of the Treaty in the French Chamber was scheduled to begin about August 26.

AUSTRIAN PEACE TERMS

Paris, July 20.—The full peace conditions of the Allied and Associated Powers are now in the hands of the Austrians.

In addition to the published summary of the terms of June 2, the new clauses provide for the reparation arrangements very similar to those in the treaty with Germany, including the establishment of an Austrian subsection of the Reparations Commission, the payment of a reasonable sum in cash, the issuing of bonds, and the delivery of livestock and certain historical and art documents.

The financial terms provide that the Austrian pre-war debt shall be apportioned among the former parts of Austria, and that the Austrian coinage and war bonds circulating in the separated territory shall be taken up by the new Governments and redeemed as they see fit.

Under the military terms the Austrian army is henceforth reduced to 30,000 men on a purely voluntary basis.—*N. Y. Times*, 21/6.

BULGARIAN PEACE SETTLEMENT.

Paris dispatches of July 25 announced that the Bulgarian Peace Commissioners would arrive in Paris on the following day, that the Bulgarian Treaty was nearly completed, and that the reparation demanded of Bulgaria would be from $2,000,000,000 to $3,000,000,000.

The chief difficulty of the Balkan settlement lay in the disposition of Thrace, a name applied to the rich tobacco country lying east of Macedonia and south of Bulgaria on the Ægean Sea, inhabited by a mixed population, and claimed by both Bulgaria and Greece.

Paris, Aug. 8.—The solution arrived at, the *Intransigeant* says, provides for dividing Thrace into Eastern and Western Thrace. Eastern Thrace will be divided into three parts, Greece getting two of them and a third being designated as a part of the future free State of Constantinople.

Of Western Thrace, a quarter is to be given to Greece and the other three-quarters are to constitute a free State to be set up under the League of Nations.

A commission of technical experts will be sent to Thrace to put the solution into practical form, it is said.

According to the probable designation of Thrace and its projected partition, Bulgaria will be completely shut out from the Ægean Sea, on which she secured a coast line from the Mesta to the town of Enos, (about 80 miles,) in 1913, while Greece will secure the rich tobacco lands of the Kavala region already given her, however, by the Buchanan treaty. The future free State of Constantinople, on the east, will secure the Dedeaghatch railway and Maritza River system leading north to the junction with the Belgrade-Constantinople-Orient Railway at Adrianople.—*N. Y. Times*, 17/7.

JAPAN AND CHINA

JAPAN EXPLAINS POLICY.—Prompted by opposition in the United States and elsewhere to the terms of the Shantung settlement, Viscount Uchida, Japanese Minister of Foreign Affairs, issued on August 3 a statement to the effect that Japan was ready to hand back the Shantung Peninsula to China, retaining only the economic privileges formerly held by Germany, and to begin negotiations to that end "as soon as possible after the ratification of the Peace Treaty by Japan." He further stated that Tsingtao would be made a general foreign instead of an exclusively Japanese settlement, and that the Kiao-Chau-Tsinan-Fu Railway would be operated as a "joint Japanese-Chinese enterprise without any discrimination in treatment against the people of any nation." The statement reads:

It appears that, in spite of the official statement which the Japanese Delegation at Paris issued on May 5 last, and which I fully stated in an interview with the representatives of the press on May 17, Japan's policy respecting the Shantung question is little understood or appreciated abroad.

It will be remembered that in the ultimatum which the Japanese Government addressed to the German Government on Aug. 15, 1914, they demanded of Germany to deliver, on a date not later than Sept. 15, 1914, to the

imperial authorities, without condition of compensation, the entire leased territory of Kiao-Chau with a view to eventual restoration of the same to China. The terms of that demand have never elicited any protest on the part of China or any other Allied or Associated Powers.

Following the same line of policy, Japan now claims as one of the essential conditions of peace that the leased territory of Kiao-Chau should be surrendered to her without condition or compensation. At the same time abiding faithfully by the pledge which she gave to China in 1915, she is quite willing to restore to China the whole territory in question and to enter upon negotiations with the Government at Peking as to the arrangement necessary to give effect to that pledge as soon as possible after the treaty of Versailles shall have been ratified by Japan.

Nor has she any intention to retain or to claim any rights which affect the territorial sovereignty of China in the province of Shantung. The significance of the clause appearing in Baron Makino's statement of May 5, that the policy of Japan is to hand back the Shantung peninsula in full sovereignty to China, retaining only the economic privileges granted to Germany, must be clear to all.

Upon arrangement being arrived at between Japan and China for the restitution of Kiao-Chau, the Japanese troops at present guarding that territory and the Kiao-Chau-Tsinanfu Railway will be completely withdrawn.

The Kiao-Chau-Tsinanfu Railway is intended to be operated as a joint Sino-Japanese enterprise without any discrimination in treatment against the people of any nation.

The Japanese Government have, moreover, under contemplation proposals for the reestablishment in Tsingtao of a general foreign settlement, instead of the exclusive Japanese settlement which by the agreement of 1915 with China they are entitled to claim.—*N. Y. Times, 7/7.*

PRESIDENT WILSON'S COMMENT.—On August 6 President Wilson explained his position regarding the Shantung settlement, stating that it was clearly understood at Paris that the restoration of Chinese sovereignty should be in no way contingent upon China's execution of pledges made to Japan in 1915, as might be inferred from Viscount Uchida's statement. Furthermore, the acceptance of the Shantung settlement by the United States was not to be construed as acquiescence in the policy of Japan as expressed in the China-Japanese Notes of 1915 and 1918. The President's statement follows:

The government of the United States has noted with the greatest interest the frank statement made by Viscount Uchida with regard to Japan's future policy respecting Shantung. The statement ought to serve to remove many misunderstandings which had begun to accumulate about this question.

But there are references in the statement to an agreement entered into between Japan and China in 1915 which might be misleading if not commented upon in the light of what occurred in Paris when the clauses of the Treaty affecting Shantung were under discussion. I therefore take the liberty of supplementing Viscount Uchida's statement with the following:

In the conference of the 30th of April last, where this matter was brought to a conclusion among the heads of the principal Allied and Associated Powers, the Japanese delegates, Baron Makino and Viscount Chinda, in reply to a question put by myself, declared that:

The policy of Japan is to hand back the Shantung peninsula in full sovereignty to China, retaining only the economic privileges granted to Germany, and the right to establish a settlement under the usual conditions at Tsingtao.

The owners of the railway will use special police only to insure security for traffic. They will be used for no other purpose.

"The police forces will be composed of Chinese, and such Japanese instructors as the directors of the railway may select will be appointed by the Chinese Government."

No reference was made to this policy being in any way dependent upon the execution of the agreement of 1915 to which Count Uchida appears to have referred. Indeed, I felt it my duty to say that nothing that I agreed to must be construed as an acquiescence on the part of the government of the United States in the policy of the notes exchanged between China and Japan in 1915 and 1918, and reference was made in the discussion to the enforcement of the agreements of 1915 and 1918 only in case China failed to cooperate fully in carrying out the policy outlined in the statement of Baron Makino and Viscount Chinda.

I have, of course, no doubt that Viscount Uchida had been appraised of all of the particulars of the discussion in Paris, and I am not making this statement with the idea of correcting his, but only to throw a fuller light of clarification upon a situation which ought to be relieved of every shadow of obscurity or misapprehension.

WOODROW WILSON.

—*N. Y. Times, 7/7.*

WHAT CHINA WANTS.—To satisfy China and induce her to sign the German treaty, Japan must develop or amend her April 30 undertaking by fixing a definite date, not more than a year hence, within which she will restore the Chinese political rights. She must surrender military control of the railway, police, and agree that Kiao-Chau shall be open for international settlement and not held as a permanent, exclusive Japanese settlement.—*N. Y. Times, 3/7.*

HUNGARY

BELA KUN RÉGIME OVERTHROWN.—On July 26 the Allied delegates at Paris took definite action toward a settlement of the Hungarian situation by notifying Hungary that no negotiations would be undertaken with the government then in control. Threatened by the advance of Rumanian forces and unable to secure supplies from the Allied Powers, Bela Kun voluntarily resigned on July 31. With promises of assistance from Paris, a new cabinet was set up with Jules Peidll as Premier.

RUMANIAN TROOPS OCCUPY BUCHAREST.—On August 4 the Rumanian Army advanced to Bucharest without opposition, and some 30,000 troops entered and occupied the city and began seizing stores and munitions. Rumania presented an ultimatum to Hungary making demands for food supplies and reduction of the army far in excess of the Armistice conditions.

The advance of Rumanian forces was in defiance of a message sent by the Supreme Council at Paris on August 2 requesting that the Rumanian forces immediately cease their invasion of Hungarian territory. This note was followed by a sharp demand on August 6 that Rumania observe the terms of the Armistice. On August 12 the Allied Military Commission at the Hungarian capital informed Paris that the Rumanian High Commissioner refused to regard instructions from the Peace Conference as orders.

ARCHDUKE JOSEPH SEIZES POWER.—On August 6 the Peidll Cabinet was overthrown by a *coup d'état* and a new ministry set up under the Archduke Joseph.

News that the Archduke Joseph had set up a new Hungarian government quickly followed that of Peidll's overthrow. The Social Democrats of

Budapest managed to get their appeal through to Paris this afternoon begging the Peace Conference to save the country from both the Rumanians and the reactionary Archduke.

But the Conference is helplessly asking what it can do. The only comment on Archduke Joseph by one of the peacemakers was:

"I fear he has monarchial tendencies."

But that is about the only attempt any one has made at a joke on the present Balkan mess.

The American and British delegates in Paris are furious over the situation, at least as furious as plenipotentiaries ever allow themselves to get. The French, although impressed by the seriousness of the situation, cannot refrain from chuckling a little over the miscarriage of the Hungarian policy, which they disapproved from the start, because it did not agree with their desire to send a large military force, chiefly American, to Hungary. But the Italians are more frankly disturbed than anybody else by this coming to the front of Archduke Joseph. Italy's traditional fear and hatred of Austria-Hungary is associated only with the aristocracy of the old dual monarchy.

Peace Headquarters do not share Italy's fears in that direction. There is much more alarm that the overthrow of Peidll will soon lead to the recurrence of Bolshevism in Hungary, which the Allies thought they had got rid of with Bela Kun.

Regardless of the difference of opinions on various phases of the situation, the delegates in Paris are beginning to wonder if they would not have had an easier task restoring peace in Europe if they had left Austria-Hungary intact, as they might have done instead of cutting up and trying so many experiments at one time in setting up small and independent liberty-loving states.—*N. Y. Times*, 8/7.

FRANCE

CHAMBER SUPPORTS CLEMENCEAU.— Following the vote in the French Chamber of Deputies on July 18, which went against the Clemenceau Government and forced the resignation of Food Minister Boret, attacks on the government were renewed during the following week. On July 22 the Chamber gave the government a vote of confidence by a majority of 272 to 181 and on July 24 by a majority of 304 to 134. On the second occasion attacks were directed against Ministers of Finance Klotz and his policy. M. Klotz expressed faith in the ability of France to emerge from what he described as her difficult but not desperate financial straits.

RUSSIA

KOLCHAK GOVERNMENT THREATENED.—Press dispatches during the early part of August mingled reports of the collapse of Bolshevism and the resignation of Lenine with a record of military events of quite contrary significance. On August 1 it was reported that the morale of the Kolchak forces was low, that they had retreated 200 miles from their advanced lines, and later that the Omsk Government was preparing to remove to Irkutsk, Siberia, a distance of about 600 miles.

Ambassador Morris's Report.—Washington, August 11.—Complete collapse of the Kolchak movement in Siberia was forecast in reports reaching Washington to-day. Kolchak forces have fallen back almost 200 miles from their former advanced lines and Omsk was said to be threatened with evacuation.

Failure of the Allied and Associated Governments to get adequate supplies to Admiral Kolchak, the advices said, had forced him to fall back steadily before the greatly superior Bolsheviki forces composed of veterans,

whose officers include many Germans who fled to Russia when the Armistice was signed.

Officials here are known to regard Kolchak's efforts at an end unless most radical measures are adopted by outside governments and it was suggested that the President might call the attention of Congress to the imminence of Bolshevik control of all Serbia.

The proposition of extending aid to Admiral Kolchak received the support of President Wilson and his associates at the Peace Conference in Paris, but the getting of supplies to him was found to be more of a military than a diplomatic problem.

France, England, and Japan were in position politically to offer supplies, but the position of the United States was not so clear on that point. Some officials in Washington held that for the United States to participate in any extensive support either in supplying the forces or in adding man-power to the army, congressional action would be necessary.—*N. Y. Herald, 12/7.*

MEXICO

BAN ON ARMS EXPORTS.—President Wilson on July 22 issued a proclamation prohibiting the export of arms and munitions to Mexico, on the ground that a state of domestic violence existed in Mexico warranting such action as provided by an act of Congress.

SENATE INVESTIGATES MEXICAN RELATIONS.—During the latter part of July Congress entered upon preliminary examination of the Mexican situation with a view to the appointment of a special investigating committee. Mr. Henry P. Fletcher, American Ambassador to Mexico, in testimony before the House Rules Committee on July 22, presented a list of 217 Americans killed by Mexicans, 137 since the Carranza régime, with no evidence, in the great majority of cases, that arrests or adequate reparation had been made.

The Senate Foreign Relations Committee on August 8 appointed a special committee composed of Senators Fall, Smith of Arizona, and Brandagee, to make an investigation. Senator King, who offered the resolution creating the committee, proposed the following program:

A thorough investigation to uncover the true situation in Mexico, followed by:

A peremptory demand by this government for the immediate adoption and enforcement by Mexico of measures for the protection of American citizens and interests in Mexico, all confiscated or looted property to be returned at once.

Reparation to be immediately assured for all classes of damages sustained, whether through loss of life or through seizure or destruction of property.

Creation of a commission to determine the exact measure of all damages. Senator King suggests a commission of one American, one Mexican and one neutral, or if preferable, a commission of five neutrals.

Negotiation of a treaty providing for Mexican liquidation of the bill as determined by such a commission. In event of failure on Mexico's part a prompt blockade of Mexican ports and administration of the customs until the damages are liquidated.

"It is impossible to estimate the amount of damages that Americans will claim," said Senator King. "Fully ten thousand Americans from Utah and Arizona have been driven out of Mexico and have damage claims. Some run up to $150,000 or even $200,000. These are entirely aside from indemnities for lives lost. They likewise do not include the damages sustained by mining, railroad, oil, sugar, and other big plantation concerns and the like. The aggregate of damage claims will be from $200,000,000 to $500,000,000 and perhaps still larger."—*N. Y. Times, 11/7.*

REVIEW OF BOOKS
ON
SUBJECTS OF PROFESSIONAL INTEREST

"A Report On Medical and Surgical Developments of the War." By William Seaman Bainbridge, Lieut. Commander, Medical Corps, U. S. N. R. F.

A special number of the U. S. Naval Medical Bulletin, January, 1919, comprises this report. The author in his foreword states that the observations were made on the Western Front and in England during December, 1917, and the first six months of 1918, with added data obtained in Germany during the Autumn of 1915. The object of the survey was to record the surgical lessons of the present war, based on the experience of the Allies, for the benefit of the medical officers and hospital corpsmen on active service. Recognizing the temptation to go into detail, with such a wealth of material gathered, the author has satisfactorily adhered to the presentation of the principal points which have a practical bearing on the questions involved. As a trained surgeon of experience he was in a position to know what to look for and decide what would be of value.

The first portion of the report considers the treatment of war wounds by the Allies and the great variation of methods. The two extremes of the use of strong antiseptics or practically no antiseptics are fairly presented, with a chronological study of the evolution of treatment in the present war. The question of immediate, delayed and secondary wound suture is thoroughly discussed. Considerable space is given to the details of the Carrel-Dakin treatment which has its enthusiastic advocates as well as bitter critics. The results claimed by Carrel are "diminution in the frequency and intensity of general complications; diminution in the number of amputations; diminution in the length and cost of treatment." Those who condemn the use of all antiseptics state, "they damage still further the injured tissues and contribute nothing to the healing process or the prevention of infection." The author accepts the judgment of a number of surgeons "that while most of the methods have definite fields of usefulness, none of them is a panacea." The various other antiseptics, their method of preparation and use, are given in detail, with comments by those who advocate them. These include eusol; eupad; salt pack; dichromanine "T"; magnesium sulphate; "bipp"; flavine; crystal violet and brilliant green; hypertonic solutions; sunlight treatment; phenolisation and embalmment of septic war wounds; electricity, oxygen and ozone.

Owing to the German method of disregarding humane principles by systematic efforts to prevent leakage of information relating to military medicine and surgery, the author found it difficult to make deductions from

all he saw and heard while in that country. No one method of controlling wound infection was in use, but irrigation with hydrogen peroxide was extensively practiced in the German military hospitals. Vaccinations were used for small-pox and enteric fever. Well equipped hospitals were visited where considerable attention was given to the mental state of the patient on the principle that "the more hope and courage the better the healing and shorter the convalescence." Also the after care of the wounded soldier was emphasized with a view of returning him to the ranks, if possible, or making him self-supporting.

Among the developments of modern war-surgery has been the demonstration of the close relation between anesthesia and the extent of mortality and morbidity. "Giving the wrong anesthetic or giving the right anesthetic wrongly." As a result of experience new methods have been devised and old methods improved upon. The author discusses local and regional anesthesia; gas and oxygen, oral anesthesia, spinal anesthesia, and rectal anesthesia.

New methods of treating joint lesions and fractures have been found to obviate the necessity of amputation in many cases. C. Williams of the Belgian Military Hospital at Hoogstade has done some remarkable work that the author considers important enough to warrant the report in full of his technique. Special hospitals for fracture cases have been found necessary in order that the best treatment be assured. Certain surgeons have developed new methods which the author discusses, such as Sinclair's method of treating fractures; Willens Screw Extension Apparatus; and the apparatus of Le Clercq and Varigard.

A difficult class of cases to treat have been the trephined ones. Prof. Babinski, the leading neurologist in France, gave as his opinion of treatment for trephined patients with symptoms—"do a cranioplastic operation but do not promise too much." The use of cartilaginous grafts to repair the gap left in the skull has given good results.

War surgery always involves amputations, and in the early days of the present war there were many unnecessarily done. Better methods of treating wounds, joints and fractures have resulted in a great saving of limbs. The opinions of the leading surgeons as to the best type of amputations for the use of artificial limbs is discussed.

Plastic surgery has been one of the great developments of the war, but we must not forget the advances made in this field for the past 25 years. The ancient Hindoos were credited with performing plastic operations 2000 years ago. Restorative surgery, such as bone grafting, nerve suture, tendon transplanting, etc., has been gratifying, but the most remarkable results have been obtained in plastic surgery of the face and jaw, owing to the cooperative work between the surgeon and dentist. The author describes the work and methods used at the leading reconstruction hospitals he visited.

Trench fever has been one of the great problems of the war. The author discusses the symptomatology and measures to prevent its occurrence, especially the destruction of the louse which was found to transmit it.

The problem of evacuation of wounded from the firing line to convalescent camp, as handled by the British, is set forth at length. This includes the surgery of the forward area and transportation from the trenches to regimental aid post, advanced dressing station, field ambulance, walking wounded post, main dressing station, casualty clearing station, ambulance train, stationary hospital, ambulance transport to England, ambulance train to base or special hospitals, and finally to convalescent camps. Experience has shown the degree of surgical procedure that may be adopted at each station. Special notes of hospitals visited and surgical methods in use are given in detail. The organization, administration, and results accomplished by convalescent camps are also discussed. The author states that France and Britain early in the war recognized their responsibility for the re-education of the disabled and we should learn from them and Belgium the lessons that four years of experience have taught. Functional re-education should begin in the hospital before the wound is healed or before habits are formed conducive to permanent helplessness and reliance on others. Functional re-education by work has proved to be the most helpful, although gymnastics and special machines are useful. Vocational re-education gives a man an opportunity to learn some other trade or profession which will enable him to be self-supporting. In Europe, almost from the beginning of the war, this has been recognized and special institutions provided, some of which the author describes.

For the purpose of comparing methods and results in war surgery the American Red Cross, through Major Alexander Lambert, organized a research society which meets monthly in Paris and publishes its proceedings in a journal. The general principles guiding the treatment of wounds of war and the best accepted methods for each class are outlined.

In completing his report the author discusses miscellaneous subjects, such as the modern treatment of burns by ambrine; suggests plans for an evacuation hospital; gives a proposed organization of educational service in war surgery; and offers special suggestions regarding disposal of U. S. Army casualties.

Finally, as a result of his survey, the author makes several recommendations which he believes may be helpful. Medical officers should read this excellent report in full, as it is worth careful study.

D. N. C.

NOTICE TO MEMBERS

More members, both regular and associate, are much desired. Any increase in membership invariably means larger number of papers and essays submitted, and consequently an improvement in the PROCEEDINGS.

You are requested to send or give the attached slip to some one eligible for membership, urging him to join.

By direction of the Board of Control,

S. A. Taffinder,
Secretary-Treasurer.

Attention is invited to extracts from the constitution on the opposite page as to the requirements in making applications for life, regular and associate membership. Members and associate members are liable for the payment of the annual dues until the date of the receipt of their resignation in writing. Annual dues $2.50.

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To the Secretary and Treasurer,
U. S. Naval Institute,
Annapolis, Md.

Dear Sir:

Please enroll my name as a {regular / associate} member of the U. S. Naval Institute from this date.

Very truly yours,

....

....

NOTICE

The U. S. Naval Institute was established in 1873, having for its object the advancement of professional and scientific knowledge in the Navy. It is now in its forty-sixth year of existence, trusting as heretofore for its support to the officers and friends of the Navy. The members of the Board of Control cordially invite the co-operation and aid of their brother officers and others interested in the Navy, in furtherance of the aims of the Institute, by the contribution of papers and communications upon subjects of interest to the naval profession, as well as by personal support and influence.

On the subject of membership the Constitution reads as follows:

ARTICLE VII

Sec. 1. The Institute shall consist of regular, life, honorary and associate members.

Sec. 2. Officers of the Navy, Marine Corps, and all civil officers attached to the Naval Service, shall be entitled to become regular or life members, without ballot, on payment of dues or fees to the Secretary and Treasurer. Members who resign from the Navy subsequent to joining the Institute will be regarded as belonging to the class described in this Section.

Sec. 3. The Prize Essayist of each year shall be a life member without payment of fee.

Sec. 4. Honorary members shall be selected from distinguished Naval and Military Officers, and from eminent men of learning in civil life. The Secretary of the Navy shall be, *ex officio,* an honorary member. Their number shall not exceed thirty (30). Nominations for honorary members must be favorably reported by the Board of Control. To be declared elected, they must receive the affirmative vote of three-quarters of the members represented at regular or stated meetings, either in person or by proxy.

Sec. 5. Associate members shall be elected from Officers of the Army, Revenue Cutter Service, foreign officers of the Naval and Military professions, and from persons in civil life who may be interested in the purposes of the Institute.

Sec. 6. Those entitled to become associate members may be elected life members, provided that the number not officially connected with the Navy and Marine Corps shall not at any time exceed one hundred (100).

Sec. 7. Associate members and life members, other than those entitled to regular membership, shall be elected as follows: "Nominations shall be made in writing to the Secretary and Treasurer, with the name of the member making them, and such nominations shall be submitted to the Board of Control. The Board of Control will at each regular meeting ballot on the nominations submitted for election, and nominees receiving a majority of the votes of the board membership shall be considered elected to membership in the United States Naval Institute."

Sec. 8. The annual dues for regular and associate members shall be two dollars and fifty cents, all of which shall be for a year's subscription to the UNITED STATES NAVAL INSTITUTE PROCEEDINGS, payable upon joining the Institute, and upon the first day of each succeeding January. The fee for life membership shall be forty dollars, but if any regular or associate member has paid his dues for the year in which he wishes to be transferred to life membership, or has paid his dues for any future year or years, the amount so paid shall be deducted from the fee for life membership.

ARTICLE X

Sec. 2. One copy of the PROCEEDINGS, when published, shall be furnished to each regular and associate member (in return for dues paid), to each life member (in return for life membership fee paid), to honorary members, to each corresponding society of the Institute, and to such libraries and periodicals as may be determined upon by the Board of Control.

The PROCEEDINGS are published monthly; subscription for non-members, \$3.00; enlisted men, U. S. Navy, \$2.50. Single copies, by purchase, 30 cents; issues preceding January, 1919, 50 cents.

All letters should be addressed U. S. Naval Institute, Annapolis, Md., and all checks, drafts, and money orders should be made payable to the same.

SPECIAL NOTICE

NAVAL INSTITUTE PRIZE ESSAY, 1920

A prize of two hundred dollars, with a gold medal, and a life-membership (unless the author is already a life member) in the Institute, is offered by the Naval Institute for the best original essay on any subject pertaining to the naval profession published in the PROCEEDINGS during the current year. The prize will be in addition to the author's compensation paid upon publication of the essay.

On the opposite page are given suggested topics. Essays are not limited to these topics and no additional weight will be given an essay in awarding the prize because it is written on one of these suggested topics over one written on any subject pertaining to the naval profession.

The following rules will govern this competition:

1. All original essays published in the PROCEEDINGS during 1919, which are deemed by the Board of Control to be of sufficient merit, will be passed upon by the Board during the month of January, 1920, and the award for the prize will be made by the Board of Control, voting by ballot.

2. No essay received after November 1 will be available for publication in 1919. Essays received subsequent to November 1, if accepted, will be published as soon as practicable thereafter.

3. If, in the opinion of the Board of Control, the best essay published during 1919 is not of sufficient merit to be awarded the prize, it may receive "Honorable Mention," or such other distinction as the Board may decide.

4. In case one or more essays receive "Honorable Mention," the writers thereof will receive a minimum prize of seventy-five dollars and a life-membership (unless the author is already a life member) in the Institute, the actual amounts of the awards to be decided by the Board of Control in each case.

5. It is requested that all essays be submitted typewritten and in duplicate; essays submitted written in longhand and in single copy will, however, receive equal consideration.

6. In the event of the prize being awarded to the winner of a previous year, a gold clasp, suitably engraved, will be given in lieu of the gold medal.

By direction of the Board of Control.

S. A. TAFFINDER,
Commander, U. S. N., Secretary and Treasurer.

TOPICS FOR ESSAYS

Suggested by Request of the Board of Control

"Duties and Responsibilities of Subordinates with Special Reference to the Relations between Commanders-in-Chief and Chief of Naval Operations; Commanders-in-Chief and Force Commanders; Force Commanders and Division Commanders."

"Initiative of the Subordinate—Its True Meaning."

"Military Efficiency Dependent upon National Discipline."

"Governmental Organization for War."

"Naval Gunnery, Now and of the Future."

"Naval Policies."

"The Place of the Naval Officer in International Affairs."

"Moral Preparedness."

"Tact in Relation to Discipline."

"The Principles of Naval Administration in Support of War-Time Operations."

"Responsibilities and Duties of Naval and Military Officers of the United States in Educating and Informing the Public on Professional Matters."

"A Commission in The Navy: Its Meaning and the Obligations Which It Involves."

"The Relations of an Officer to his Subordinate, Both Commissioned and Enlisted."

"The True Meaning of the Expression 'An Officer and a Gentleman.'"

"Seen in the Light of Recent Events, What Should Be the United States Navy of the Future as Regards Types and Numbers of Ships."

"Probable Future Development of Surface-craft, Air-craft and Submarines and the Relation of these Types to Each Other and to Naval Warfare in General."

"The Grand Strategy of the Great War, with Especial Reference to Coördination, and Lack of Coördination, Between Naval and Military Forces."

"The Problem of Overseas Operations in the Light of Recent Developments."

"The Influence of Sea Power upon History as Illustrated by the Great War."

LIST OF PRIZE ESSAYS

"WHAT THE NAVY HAS BEEN THINKING ABOUT"

1879

Naval Education. Prize Essay, 1879. By Lieut. Commander A. D. Brown, U. S. N.

NAVAL EDUCATION. First Honorable Mention. By Lieut. Commander C. F. Goodrich, U. S. N.

NAVAL EDUCATION. Second Honorable Mention. By Commander A. T. Mahan, U. S. N.

1880

"The Naval Policy of the United States." Prize Essay, 1880. By Lieutenant Charles Belknap, U. S. N.

1881

The Type of (I) Armored Vessel, (II) Cruiser Best Suited to the Present Needs of the United States. Prize Essay, 1881. By Lieutenant E. W. Very, U. S. N.

SECOND PRIZE ESSAY, 1881. By Lieutenant Seaton Schroeder, U. S. N.

1882

Our Merchant Marine: The Causes of Its Decline and the Means to Be Taken for Its Revival. "Nil clarius aquis." Prize Essay, 1882. By Lieutenant J. D. Kelley, U. S. N.

"MAIS IL FAUT CULTIVER NOTRE JARDIN." Honorable Mention. By Master C. G. Calkins, U. S. N.

"SPERO MELIORA." Honorable Mention. By Lieut. Commander F. E. Chadwick, U. S. N.

"CAUSA LATET: VIS EST NOTISSIMA." Honorable Mention. By Lieutenant R. Wainwright, U. S. N.

1883

How May the Sphere of Usefulness of Naval Officers Be Extended in Time of Peace with Advantage to the Country and the Naval Service? "Pour encourager les Autres." Prize Essay, 1883. By Lieutenant Carlos G. Calkins, U. S. N.

"SEMPER PARATUS." First Honorable Mention. By Commander N. H. Farquhar, U. S. N.

"CULIBET IN ARTE SUA CREDENDUM EST." Second Honorable Mention. By Captain A. P. Cooke, U. S. N.

1884

The Reconstruction and Increase of the Navy. Prize Essay, 1884. By Ensign W. I. Chambers, U. S. N.

1885

Inducements for Retaining Trained Seamen in the Navy, and Best System of Rewards for Long and Faithful Service. Prize Essay, 1885. By Commander N. H. Farquhar, U. S. N.

1886

What Changes in Organization and Drill Are Necessary to Sail and Fight Effectively Our Warships of Latest Type? "Scire quod nescias." Prize Essay, 1886. By Lieutenant Carlos G. Calkins, U. S. N.

THE RESULT OF ALL NAVAL ADMINISTRATION AND EFFORTS FINDS ITS EXPRESSION IN GOOD ORGANIZATION AND THOROUGH DRILL ON BOARD OF SUITABLE SHIPS. Honorable Mention. By Ensign W. L. Rodgers, U. S. N.

1887

The Naval Brigade: Its Organization, Equipment and Tactics. "In hoc signo vinces." Prize Essay, 1887. By Lieutenant C. T. Hutchins.

1888

Torpedoes. Prize Essay, 1888. By Lieut. Commander W. W. Reisinger, U. S. N.

1891

The Enlistment, Training and Organization of Crews for Our Ships of War. Prize Essay, 1891. By Ensign A. P. Niblack, U. S. N.

DISPOSITION AND EMPLOYMENT OF THE FLEET: SHIP AND SQUADRON DRILL. Honorable Mention, 1891. By Lieutenant R. C. Smith, U. S. N.

1892

Torpedo-boats: Their Organization and Conduct. Prize Essay, 1892. By Wm. Laird Clowes.

1894

The U. S. S. Vesuvius, with Special Reference to Her Pneumatic Battery. Prize Essay, 1894. By Lieut. Commander Seaton Schroeder, U. S. N.

NAVAL REFORM. Honorable Mention, 1894. By Passed Assistant Engineer F. M. Bennett, U. S. N.

1895

Tactical Problems in Naval Warfare. Prize Essay, 1895. By Lieut. Commander Richard Wainwright, U. S. N.

A SUMMARY OF THE SITUATION AND OUTLOOK IN EUROPE. An Introduction to the Study of Coming War. Honorable Mention, 1895. By Richmond Pearson Hobson, Assistant Naval Constructor, U. S. N.

SUGGESTIONS FOR INCREASING THE EFFICIENCY OF OUR NEW SHIPS. Honorable Mention, 1895. By Naval Constructor Wm. J. Baxter, U. S. N.

THE BATTLE OF THE YALU. Honorable Mention, 1895. By Ensign Frank Marble, U. S. N.

1896

The Tactics of Ships in the Line of Battle. Prize Essay, 1896. By Lieutenant A. P. Niblack, U. S. N.

THE ORGANIZATION, TRAINING AND DISCIPLINE OF THE NAVY PERSONNEL AS VIEWED FROM THE SHIP. Honorable Mention, 1896. By Lieutenant Wm. F. Fullam, U. S. N.

NAVAL APPRENTICES, INDUCEMENTS, ENLISTING AND TRAINING. The Seaman Branch of the Navy. Honorable Mention, 1896. By Ensign Ryland D. Tisdale, U. S. N.

THE COMPOSITION OF THE FLEET. Honorable Mention 1896. By Lieutenant John M. Ellicott, U. S. N.

1897

Torpedo-boat Policy. Prize Essay, 1897. By Lieutenant R. C. Smith, U. S. N.

A PROPOSED UNIFORM COURSE OF INSTRUCTION FOR THE NAVAL MILITIA. Honorable Mention, 1897. By H. G. Dohrman, Associate Member, U. S. N. I.

TORPEDOES IN EXERCISE AND BATTLE. Honorable Mention, 1897. By Lieutenant J. M. Ellicott, U. S. N.

1898

Esprit de Corps: A Tract for the Times. Prize Essay, 1898. By Captain Caspar Frederick Goodrich, U. S. N.

OUR NAVAL POWER. Honorable Mention, 1898. By Lieut. Commander Richard Wainwright, U. S. N.

TARGET PRACTICE AND THE TRAINING OF GUN CAPTAINS. Honorable Mention, 1898. By Ensign R. H. Jackson, U. S. N.

1900

Torpedo Craft: Types and Employment. Prize Essay, 1900. By Lieutenant R. H. Jackson, U. S. N.

THE AUTOMOBILE TORPEDO AND ITS USES. Honorable Mention, 1900. By Lieutenant L. H. Chandler, U. S. N.

1901

Naval Administration and Organization. Prize Essay, 1901. By Lieutenant John Hood, U. S. N.

1903

Gunnery in Our Navy. The Causes of Its Inferiority and Their Remedies. Prize Essay, 1903. By Professor Philip R. Alger, U. S. N.

A NAVAL TRAINING POLICY AND SYSTEM. Honorable Mention, 1903. By Lieutenant James H. Reid, U. S. N.

SYSTEMATIC TRAINING OF THE ENLISTED PERSONNEL OF THE NAVY. Honorable Mention, 1903. By Lieutenant C. L. Hussey, U. S. N.

OUR TORPEDO-BOAT FLOTILLA. The Training Needed to Insure Its Efficiency. Honorable Mention, 1903. By Lieutenant E. L. Beach, U. S. N.

1904

The Fleet and Its Personnel. Prize Essay, 1904. By Lieutenant S. P. Fullinwider, U. S. N.

A PLEA FOR A HIGHER PHYSICAL, MORAL AND INTELLECTUAL STANDARD OF THE PERSONNEL FOR THE NAVY. Honorable Mention, 1904. By Medical Inspector Howard E. Ames, U. S. N.

1905

American Naval Policy. Prize, Essay 1905. By Commander Bradley A. Fiske, U. S. N.

THE DEPARTMENT OF THE NAVY. Honorable Mention, 1905. By Rear Admiral Stephen B. Luce, U. S. N.

1906

Promotion by Selection. Prize Essay, 1906. By Commander Hawley O. Rittenhouse, U. S. N.

THE ELEMENTS OF FLEET TACTICS. First Honorable Mention, 1906. By Lieut. Commander A. P. Niblack, U. S. N.

GLEANINGS FROM THE SEA OF JAPAN. Second Honorable Mention, 1906. By Captain Seaton Schroeder, U. S. N.

THE PURCHASE SYSTEM OF THE NAVY. Third Honorable Mention, 1906 By Pay Inspector J. A. Mudd. U. S. N.

1907

Storekeeping at the Navy Yards. Prize Essay, 1907. By Pay Inspector John A. Mudd, U. S. N.

BATTLE REHEARSALS. A Few Thoughts on Our Next Step in Fleet-Gunnery. First Honorable Mention, 1907. By Lieut. Commander Yates Stirling, U. S. N.

THE NAVAL PROFESSION. Second Honorable Mention, 1907. By Commander Bradley A. Fiske, U. S. N.

1908

A Few Hints to the Study of Naval Tactics. Prize Essay, 1908. By Lieutenant W. S. Pye, U. S. N.

THE MONEY FOR THE NAVY. First Honorable Mention, 1908. By Pay Inspector John A. Mudd, U. S. N.

THE NATION'S DEFENCE—THE OFFENSIVE FLEET. How Shall We Prepare It for Battle? Second Honorable Mention, 1908. By Lieut. Commander Yates Stirling, U. S. N.

1909

Some Ideas about Organization on Board Ship. Prize Essay, 1909. By Lieutenant Ernest J. King, U. S. N.

THE NAVY AND COAST DEFENCE. Honorable Mention, 1909. By Commodore W. H. Beehler, U. S. N.

THE REORGANIZATION OF THE NAVAL ESTABLISHMENT. Honorable Mention, 1909. By Pay Inspector J. A. Mudd, U. S. N.

A PLEA FOR PHYSICAL TRAINING IN THE NAVY. Honorable Mention, 1909. By Commander A. P. Niblack, U. S. N.

1910

The Merchant Marine and the Navy. Prize Essay, 1910. By Naval Constructor T. G. Roberts, U. S. N.

THE NAVAL STRATEGY OF THE RUSSO-JAPANESE WAR. Honorable Mention, 1910. By Lieutenant Lyman A. Cotton, U. S. N.

1911

Navy Yard Economy. Prize Essay, 1911. By Paymaster Charles Conard, U. S. N.

NAVAL POWER. Honorable Mention, 1911. By Captain Bradley A. Fiske, U. S. N.

WANTED—FIRST AID. Honorable Mention, 1911. By Commander C. C. Marsh, U. S. N.

1912

Naval Might. Prize Essay, 1912. By Lieutenant Ridgely Hunt, U. S. N. (retired).

INSPECTION DUTY AT THE NAVY YARDS. Honorable Mention, 1912. By Lieut. Commander T. D. Parker, U. S. N.

1913

The Greatest Need of the Atlantic Fleet. Prize Essay, 1913. By Lieut. Commander Harry E. Yarnell, U. S. N.

NAVY DEPARTMENT ORGANIZATION. A Study of Principles. First Honorable Mention, 1913. By Commander Yates Stirling, Jr., U. S. N.

TRAINED INITIATIVE AND UNITY OF ACTION. Second Honorable Mention, 1913. By Lieut. Commander Dudley W. Knox, U. S. N.

1914

The Great Lesson from Nelson for To-day. Prize Essay, 1914. By Lieut. Commander Dudley W. Knox, U. S. N.

NAVAL POLICY AS IT RELATES TO THE SHORE ESTABLISHMENT AND THE MAINTENANCE OF THE FLEET. Honorable Mention, 1914. By Captain John Hood, U. S. N.

OLD PRINCIPLES AND MODERN APPLICATIONS. Honorable Mention, 1914. By Lieut. Commander Dudley W. Knox, U. S. N.

MILITARY PREPAREDNESS. Honorable Mention, 1914. By Naval Constructor Richard D. Gatewood, U. S. N.

1915

The Rôle of Doctrine in Naval Warfare. Prize Essay, 1915. By Lieut. Commander Dudley W. Knox, U. S. N.

AN AIR FLEET: OUR PRESSING NAVAL WANT. First Honorable Mention, 1915. By Lieut. Commander Thomas Drayton Parker, U. S. N.

TACTICS. Second Honorable Mention, 1915. By Ensign H. H. Frost, U. S. N.

DEFENCE AGAINST SURPRISE TORPEDO ATTACK. Third Honorable Mention, 1915. By Ensign R. T. Merrill, 2d, U. S. N.

1916

The Moral Factor in War. Prize Essay, 1916. By Lieutenant (J. G.) H. H. Frost, U. S. N.

NAVAL PERSONNEL. First Honorable Mention, 1916. By Lieut. Commander J. K. Taussig, U. S. N.

EDUCATION AT THE U. S. NAVAL ACADEMY. Second Honorable Mention, 1916. By Lieutenant Ridgely Hunt, U. S. N.

SOME UNDERLYING PRINCIPLES OF MORALE. Third Honorable Mention, 1916. By Commander Dudley W. Knox, U. S. N.

LARGE *vs.* A GREATER NUMBER OF SMALLER BATTLESHIPS. Lippincott Prize Essay. By Lieut. Commander Thomas Lee Johnson, U. S. N.

1917

Commerce Destroying in War. Prize Essay, 1917. By Commander Lyman A. Cotten, U. S. Navy.

THE PEOPLE'S RÔLE IN WAR. First Honorable Mention, 1917. By Lieutenant H. H. Frost, U. S. Navy.

THE NATION'S GREATEST NEED. Second Honorable Mention, 1917. By Colonel Dion Williams, U. S. Marine Corps.

1918

Letters on Naval Tactics. Prize Essay, 1918. By Lieutenant H. H. Frost, U. S. N.

THE PREPAREDNESS OF THE FUTURE. First Honorable mention, 1918. By Commander H. O. Rittenhouse, U. S. N. Retired.

NAVAL STRATEGY. Second Honorable Mention, 1918. By Rear Admiral Bradley A. Fiske, U. S. N.

1919

MILITARY CHARACTER. First Honorable Mention, 1918. By Captain Reginald R. Belknap, U. S. N.

SOME REFLECTIONS ON THE THREE FACTORS OF BATTLESHIP DESIGN. Second Honorable Mention, 1918. By Lieut. Commander Beirne S. Bullard, C. C., U. S. N.

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